MARSHALL "LOCOMOBILES"

PUBLICATION NO. 1480

THE weights and measurements of Engines and Machinery, and the work they will severally perform, as given by us, must be taken as approximate only.

It must be understood that the illustrations are not binding as to detail, but must simply be taken as conveying a general representation of the Machinery, as in some cases the various sizes of the same article differ both in form and detail. Moreover, we reserve the right to modify details according to improved practice.

All orders entrusted to us have our best attention, but we beg to notify that we cannot at all times guarantee punctual delivery, and therefore must not be held liable in the event of any delay.

All dates for delivery are given subject to a reasonable extension of time to be allowed in cases of Strikes, Lockouts, War Conditions, and other circumstances beyond our control.

M. S & Co. Ltd.

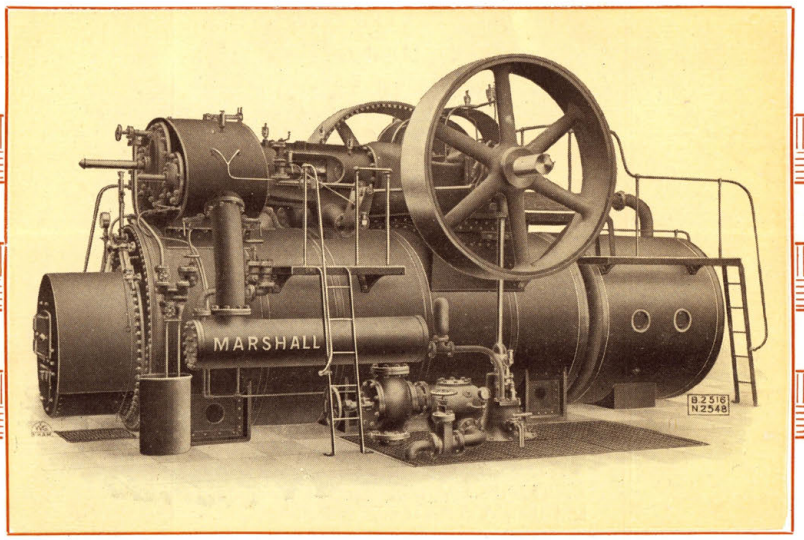
Publication No. 1480
Supersedes No. 1334

MARSHALL

HIGH ECONOMY

Superheated-Steam Semi-Portable ENGINES

"LOCOMOBILES"



FOR INDUSTRIAL POWER PURPOSES

MANUFACTURED BY

Marshall, Sons & Company Ltd.

ENGINEERS AND BOILERMAKERS

BRITANNIA WORKS, **GAINSBOROUGH,** LINCS., ENGLAND

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International Exhibition
TURIN, Italy
1911

Three Grands Prix
HIGHEST AWARD IN EACH OF THE THREE CLASSES ENTERED

MARSHALL ~ SONS & Co LD GAINSBOROVGH ENGLAND
GRAN PREMIO TORINO MCMXI
ESPOSIZIONE DELLE INDVSTRIE
INTERNAZIONALE E DEL LAVORO

International Exhibition
BRUSSELS,
1910

Two Grands Prix and GOLD MEDAL
FOR OUR ENGINES AND MACHINERY

DURING the last 60 years down to the present day, in competition with other manufacturers of all countries, we have received over

500 SEPARATE AWARDS

INCLUDING

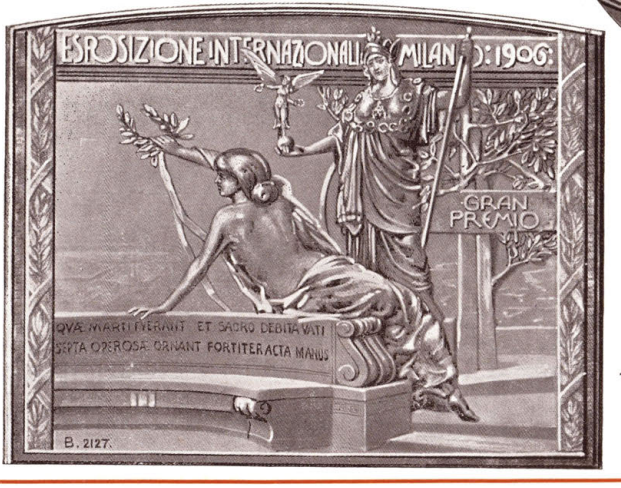
Grands Prix
Diplomas of Honour
Gold and Silver Medals

FOR GENERAL EXCELLENCE OF OUR PRODUCTIONS

Extract from the Judges' Award at the SYDNEY INTERNATIONAL EXHIBITION

"Marshall, Sons & Co.'s Engines deserve the highest commendation for their General Proportions, their Elegance and Symmetrical Design, their Arrangements for adjustment and their Workmanship and Finish."

International Exhibition
MILAN, Italy
1906
GRAND PRIX and DIPLOMA OF HONOUR
FOR OUR ENGINES AND MACHINERY

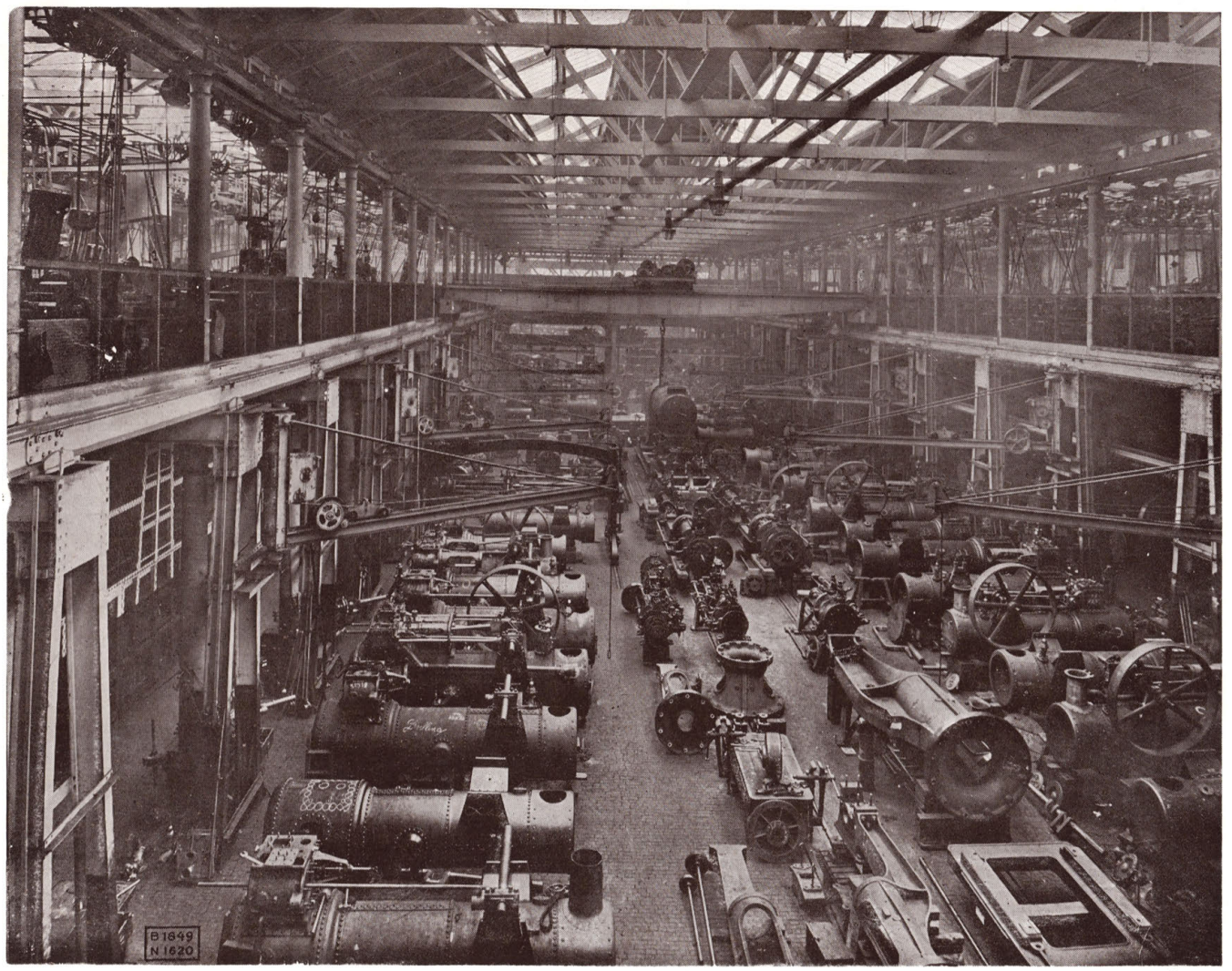

ESPOSIZIONE INTERNAZIONALE MILANO 1906
GRAN PREMIO
QVÆ MARTI FERRVNT ET SACRO DEBITA VATI
SEPTA OPEROSA ORNANT FORTITER ACTA MANVS
B. 2127.

International Exhibition
SANTIAGO, Chile
1910
GRAND PRIX
THE ONLY GRAND PRIX AWARDED FOR PORTABLE ENGINES

UNITED PROVINCES EXHIBITION, ALLAHABAD, INDIA, 1910-1911

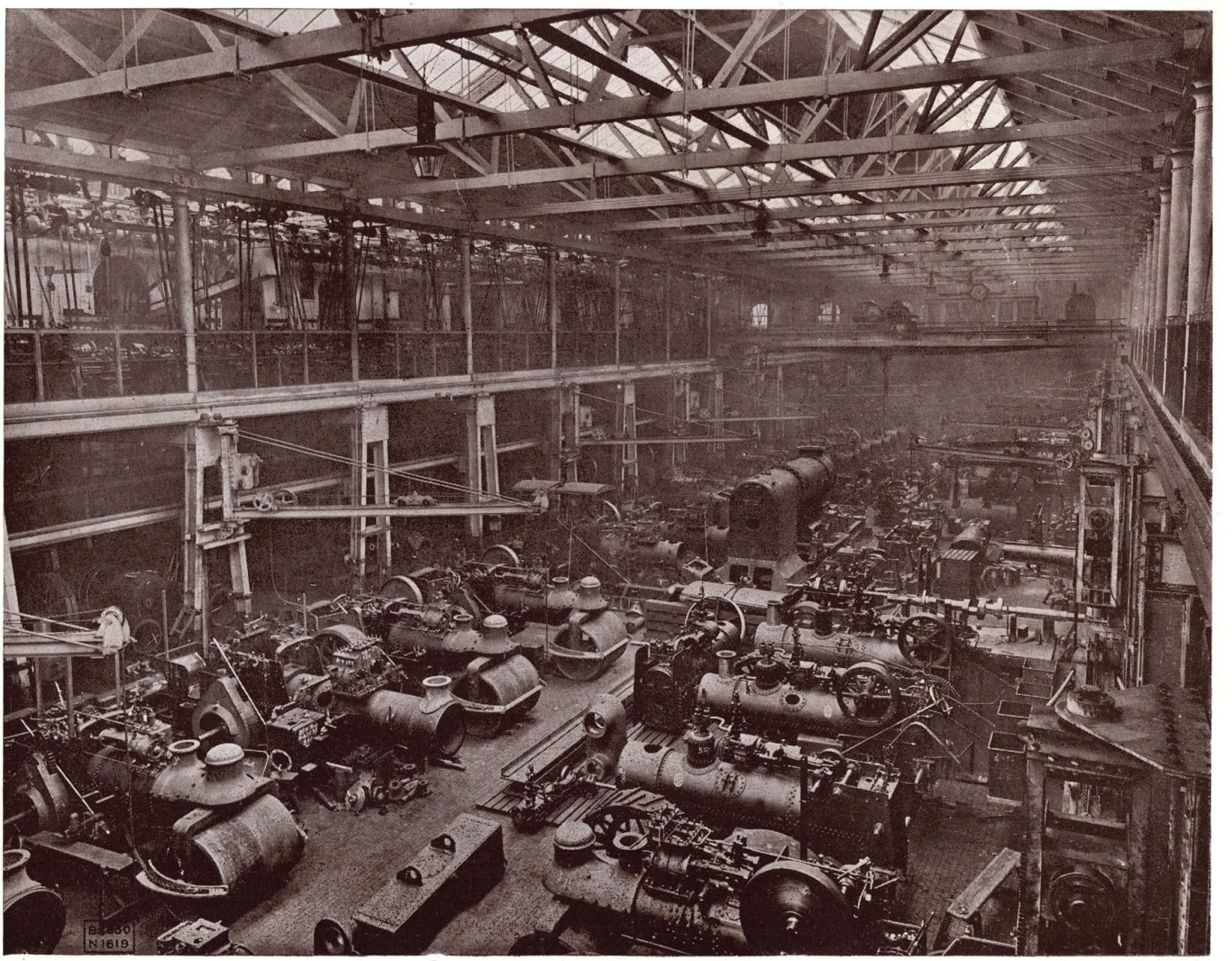
Grand Prix, Four Gold Medals, and Silver Cup

"MARSHALL" WORKS



View of an Erecting Bay in our Engineering Department at Britannia Works, Gainsborough, looking North.

"MARSHALL" WORKS



View of an Erecting Bay in our Engineering Department at Britannia Works, Gainsborough, looking South.

INTRODUCTION

IN this publication we have the pleasure to illustrate and describe the

Marshall "Locomobiles,"

Superheated Steam Semi-Portable Engines

for industrial and other power purposes.

The designs of these Engines conform to the best practice of the present day, and the approved principles of thermo-technics. The raw materials used in their construction are subjected to exacting physical and analytical tests in our Laboratory to ensure uniformity of quality and suitable strengths. All manufacturing work in Foundry, Forge, Machine Tool and Erecting Departments is carried out by skilled workmen, on **thoroughly modern systems of standardization** and under the supervision of experts; so that every component part is the best of its respective class, scientifically suited and finished for its particular function.

Our Works cover upwards of 45 acres, and under normal conditions, employ about 5,000 men. In every department of our establishment, excellent management and sound organisation are in evidence. The workshops are replete with the most modern machine tools and mechanical appliances, and the Boiler Department, which has an average output of fifty boilers per week, is recognised as one of the best-equipped in the United Kingdom.

"Marshall" association with engines of the semi-portable and allied types dates as far back as the early "fifties" of the last century. The type of Engine now offered is the direct outcome of accumulated experience and successful evolution, and represents the self-contained high-economy steam Engine for industrial power in its most compact, convenient and efficient form.

As a matter of immediate interest to prospective purchasers of "Marshall" Engines, it may be related that since the establishment of our firm in 1848, upwards of

184,000 Engines, Boilers, etc.,

representing the **enormous aggregate of over 4 millions indicated horse power** have been manufactured at our Works, and sold for service in all parts of the world.

In ample proof of the **marked superiority of "Marshall" Engines** we have been awarded over

500 Grands Prix, Gold and Silver Medals

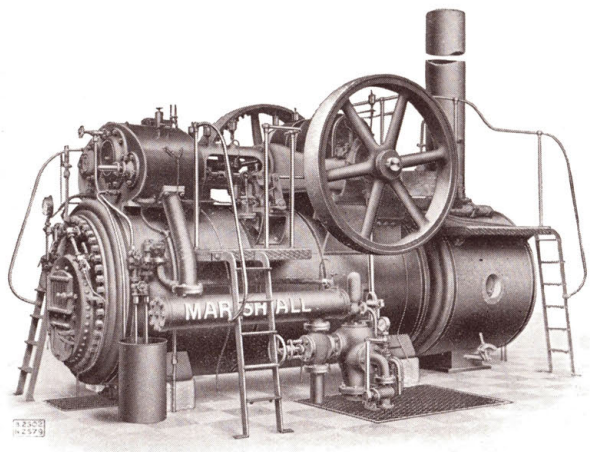
for the general excellence of our productions, as exhibited at the principal International and Agricultural Exhibitions held during the last sixty years. These awards were obtained in the face of keen competition, and after the merits of the exhibits had been subjected to the scrutiny of experts.

Throughout the world, "Marshall" Engines have become renowned for high-grade workmanship, simplicity of mechanical detail, economical operation and unquestionable durability; and such a reputation naturally conveys a valuable assurance respecting any production which comes from our establishment.

It is, therefore, believed that the splendid series of Engines described in this publication will still further enhance the high reputation enjoyed by us, and at the same time will afford every reasonable satisfaction to Power Users who adopt this thoroughly modern and economical type of steam engine.

Marshall, Sons & Co. Ltd.

BRITANNIA IRONWORKS,
GAINSBOROUGH.



"Marshall"
Superheated Steam Semi-Portable Engines
("Locomobiles")
FOR INDUSTRIAL POWER

THE type of Engine known as the "Locomobile" is the logical and modern development of the Semi-portable Steam Engine. The latter has been in vogue for the last 60 years and we are intimately associated with the manufacture of Engines of this type—

The "Locomobile" represents the highest thermal efficiency in Steam Engines of small powers. It is offered to compete with internal-combustion engines which work with suction producer gas, and it possesses advantages which are worthy of the attention and consideration of all power users.

¶ COMPARED WITH ANY OTHER STEAM ENGINE OF SIMILAR POWER, **the "Locomobile" is more economical in coal and steam consumption.**

¶ COMPARED WITH ANY OTHER SEPARATE STEAM ENGINE AND BOILER

It occupies less floor space, and therefore buildings to house it are less costly.

It is cheaper in first cost than similarly equipped engines.

It is more favourable for export, as freight and insurance are less.

It is more easily installed.

¶ "LOCOMOBILES," compared with other Steam Plants of corresponding powers, shew advantages in the following ratios :—

COMPARING	No. 8 "LOCOMOBILE"	DROP VALVE ENGINE, LANCASHIRE BOILER, SUPERHEATER & FEED WATER HEATER.	No. 2 "LOCOMOBILE"	SLIDE VALVE ENGINE, LOCO. TYPE BOILER & FEED WATER HEATER.	No. 1 "LOCOMOBILE"	"UNDERTYPE" COMPOUND ENGINE & LOCO. TYPE BOILER.
SPACE OCCUPIED	·55 to 1·00 **Saving 45%**		·56 to 1·00 **Saving 44%**		·8 to 1·00 **Saving 20%**	
CAPITAL OUTLAY	·86 to 1·00 **Saving 14%**		1·15 to 1·00 (Note Saving in Fuel Consumption)		1·00 to 1·00	
FUEL CONSUMPTION (Non-condensing)	·75 to 1·00 **Saving 25%**		·5 to 1·00 **Saving 50%**		·62 to 1·00 **Saving 38%**	
FREIGHT AND INSURANCE	·85 to 1·00 **Saving 15%**		·88 to 1·00 **Saving 12%**		1·00 to 1·00	

These figures shew that it is a GOOD INVESTMENT to install a "LOCOMOBILE."

Marshall "Locomobiles" (continued)

¶ COMPARED WITH SUCTION GAS PLANTS OF SIMILAR POWERS

It is more advantageous, as almost any kind of fuel can be used without the difficulties that accompany suction gas production.

It is therefore more economical in fuel consumption.

It has a greater range of power at economical working, so that when driving a load which varies considerably in power required, its economy is still more pronounced.

It is easier to start and simpler to run, whereas suction gas engines at times are difficult to start and are frequently stripped to remove fouling of valves, pistons and cylinders.

It will cope with an overload to the extent of nearly 50% above the normal load, whereas a suction gas engine will be "pulled up" entirely with quite a small increase above its rated power.

¶ THE PRINCIPAL FEATURES OF THE "LOCOMOBILE" TYPE ARE:—

High Steam Pressure.

High Steam Temperature, obtained by superheating the steam by passing through solid-drawn steel tubes placed in the smokebox.

High Piston Speed.

Efficient Feed Water Heater fitted with brass tubes giving a temperature nearly equal to the temperature of the exhaust steam.

Condensing in conjunction with an "Edwards" type air pump.

Minimisation of Heat Losses from radiation by thorough lagging of the boiler, smokebox, cylinder, and feed water heater.

Advantage is taken of the heat remaining in the waste gases to superheat the steam, of the heat in the exhaust steam to heat the feed water, and of the improved firegrate arrangement to obtain the high temperature in the firebox. **By these means the highest possible thermal efficiency is obtained.**

"Marshall"
Superheated Steam Semi-Portable Engines
("Locomobiles")

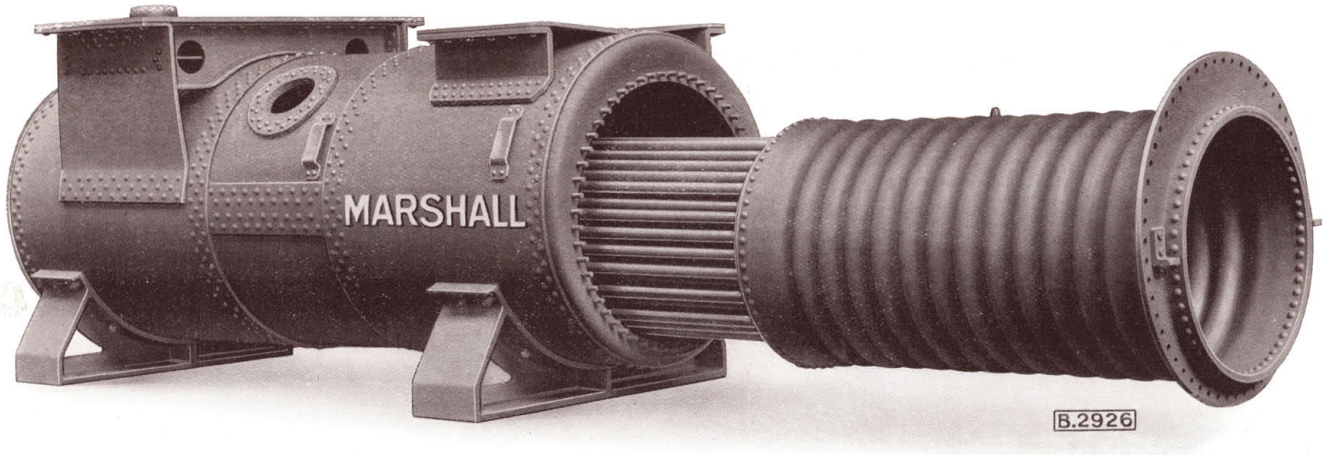
IN self-contained Engines where the engine parts are superimposed on the boiler, it is necessary for steady running that provision is made to absorb bending and vibratory stresses. **Bending stresses** are due to the steam pressures on the pistons and the resistance of the load. **Vibratory stresses** are due to the moving mass of the engine parts.

A notable feature of the Marshall "Locomobile" is the **self-contained design of the engine,** which is capable of being built as a separate unit and carried on a specially strong steel superstructure attached to the boiler. This arrangement is **unique,** and not usually found in engines of the "Locomobile" class. **It counteracts the bending stresses in a most successful way.**

Vibratory stresses are absorbed by the Boiler which by its own weight and that of the water it contains, offers a mass sufficient for the purpose without requiring expensive foundations.

The attachments to the boiler are designed to obviate any transference to the boiler of the stresses due to load on the engine, and any transference to the engine of stresses due to expansion in the boiler.

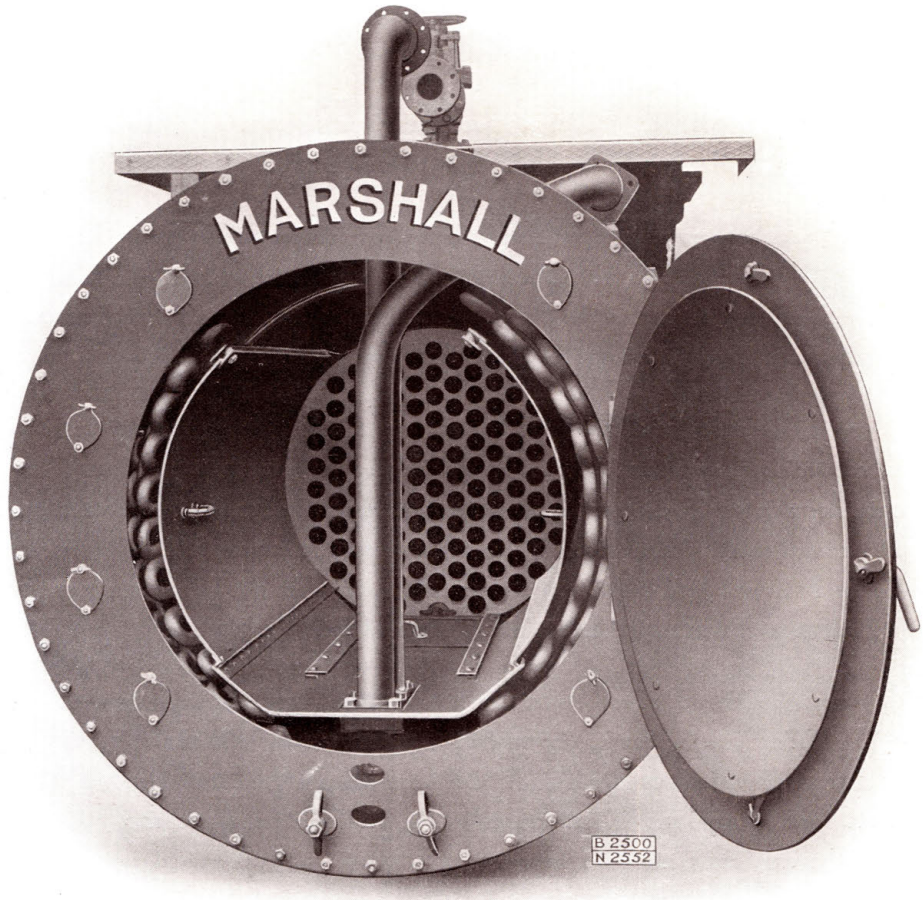
The crankshaft end is directly and rigidly attached to the cylinder end by means of the strong cross-head guides and the massive crankshaft carriages; therefore bending stresses, instead of being transmitted through the boiler as is frequently done, are met by the strength of the engine itself.



"Locomobile" Boiler, shewing tube unit partly withdrawn.

Marshall "Locomobiles" (continued)

The Boiler is designed and constructed with all the skill and experience of the " Marshall " establishment. Our boiler work is the highest class found anywhere and due entirely to the scientific selection of our materials, and excellence of our organisation and equipment.



Smokebox Interior, shewing Superheater and Baffles

A noteworthy feature of the Boiler used for our " Locomobiles " is the **withdrawable arrangement of the flue and tube unit,** whereby the whole of the interior surface of the Boiler can be made accessible for cleaning purposes.

Marshall "Locomobiles" (continued)

In spite of their increased steaming efficiency, one of the troubles of all tubulous boilers has been the difficulty experienced in removing from the tube surfaces, particularly where the tubes join the firebox, sediment caused by bad feed water. This difficulty is overcome in the "Locomobile" by the provision of the withdrawable flue, and it is possible to have a spare flue and tube unit so that a dirty Boiler can at an ordinary week-end stoppage be put into clean condition by changing the flue and tube unit. The cleaning of the dirty flue and tubes can be accomplished at a convenient time.

In places where the boiler feed water is of inferior quality, and in cases where the factory operations must be as continuous as possible, a spare flue and tube unit is very desirable.

The Superheater incorporated in our "Locomobiles" is self-contained and can be readily withdrawn from the smokebox, if required. The materials used for the superheater and the conditions under which it works, makes it almost an integral part of the Boiler. As it is not subjected to the severe straining inseparable from Boilers under steam, it will be as durable and as lasting as the Boiler itself.

It will be noted that heat from the gases (which would otherwise be wasted) is transmitted to the working steam, raising its temperature 150° to 200° Fah. above the temperature of saturation. The use of high temperature steam in this engine avoids the losses caused by initial condensation when saturated steam is used. It also considerably reduces losses by leakage through the engine, i.e., leakages past the pistons and the valves, for it is well established that superheated steam does not leak as freely as saturated steam. There is thus a double gain from superheating in a "Locomobile."

Besides the thermal efficiency of the Boiler and superheater, every effort has been made to obtain the highest mechanical efficiency possible with the engine. To this end, the **Crankshaft Bearings are made self-oiling by means of oiling rings** which dip into reservoirs in the crank carriages. The rotation of the rings with the shaft conveys the oil continuously over the bearing surfaces and maintains permanent oil films between the crankshaft and its bearings.

Special attention has also been given to devices for **automatically lubricating all other moving parts** of the engine so that they move with the least resistance and without heating up.

Being fitted with **piston valves which are completely balanced** and operated by a suitable free moving valve gear, the internal friction of the engine is reduced to a minimum, and the mechanical efficiency is very high. (See Test Figures—page 15.)

Tables of Sizes, Power Outputs, etc.
of
"Marshall" Superheated Steam Semi-Portable Engines
("Locomobiles")

WITH CONDENSERS

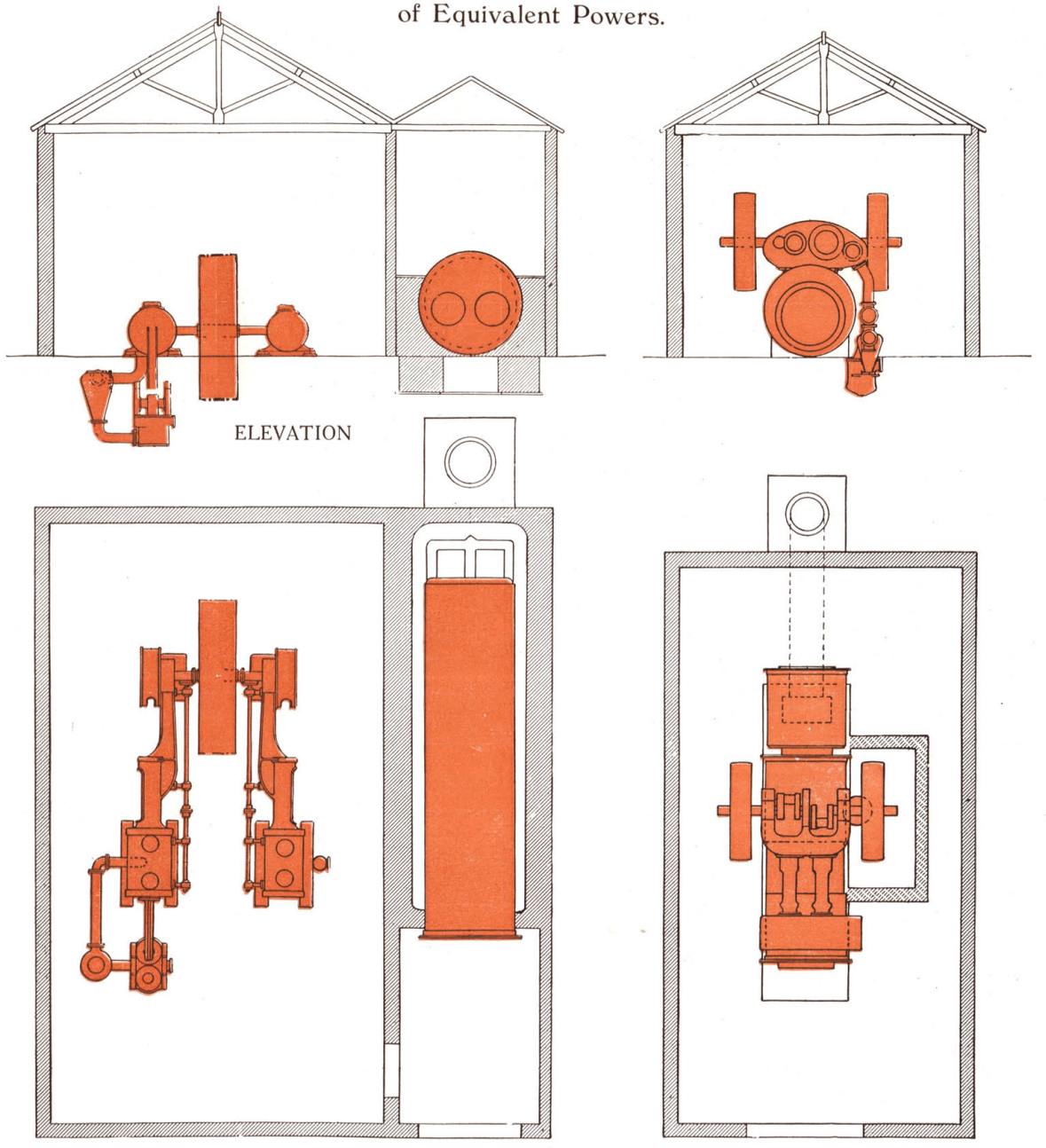
Symbol	Power Output Brake Horse Powers			Revs. per Min.	2 Flywheels		Approximate Space Occupied			Code Word
	Normal	Maximum Continuous	Maximum Momentary		Diam.	Width	Length	Width	Height to top of Fly-wheels	Condensing
					Ft. In.	In.	Ft. In.	Ft. In.	Ft. In.	
C 1	50	65	75	210	5 0	8	14 7	7 10	8 11	CAMERATAE
C 2	75	95	110	200	5 6	10	17 0	8 4	9 2	CAMERATING
C 3	100	125	140	200	5 6	12	18 0	9 1	10 0	CAMERATIO
C 4	125	150	180	200	6 0	14	18 4	9 3	10 6	CAMERATIRI
C 5	150	180	210	170	7 0	14	20 3	10 4	11 4	CAMERATOS
C 6	175	215	255	170	7 0	16	20 7	10 6	11 9	CAMERATOTE
C 7	200	260	300	165	7 6	18	21 11	13 8	12 2	CAMERATUM
C 8	250	310	350	165	7 6	20	22 7	14 0	12 7	CAMERATUSI

WITHOUT CONDENSERS

Symbol	Power Output Brake Horse Powers			Revs. per Min.	2 Flywheels		Approximate Space Occupied			Code Word
	Normal	Maximum Continuous	Maximum Momentary		Diam.	Width	Length	Width	Height to top of Fly-wheels	Non-Condensing
					Ft. In.	In.	Ft. In.	Ft. In.	Ft. In.	
N 1	38	48	60	210	5 0	8	14 7	7 10	8 11	CAMERAVI
N 2	58	70	88	200	5 6	10	17 0	8 4	9 2	CAMERAVIMO
N 3	78	95	112	200	5 6	12	18 0	9 1	10 0	CAMERAZZO
N 4	96	113	144	200	6 0	14	18 4	9 3	10 6	CAMEREM
N 5	118	135	168	170	7 0	14	20 3	10 4	11 4	CAMEREMUR
N 6	135	165	205	170	7 0	16	20 7	10 6	11 9	CAMERENT
N 7	150	195	240	165	7 6	18	21 11	13 8	12 2	CAMERERI
N 8	190	232	280	165	7 6	20	22 7	14 0	12 7	CAMERETIS

Two flywheels are provided with all "Locomobiles." In most cases it will be found desirable to drive from the flywheel on the left-hand side (i.e., when looking at the engine from the furnace end). In the larger sizes of engines, Nos. 7 and 8, we recommend that the engine power should be transmitted from **both** fly-wheels.

Diagrams Showing Space occupied by Steam Engines and Boilers and "Locomobiles" of Equivalent Powers.



The left plan and elevation shew space occupied by an ordinary installation of separate Engine and Boiler. The right hand plan and elevation shew space occupied by a "Locomobile" of equivalent power.

Power plants of the "Locomobile" type are finding considerable favour; as compared with independent engine and boiler units, they possess the undermentioned desirable features :—

Minimum Space occupied. : Small and Cheaply Constructed Building required.
Inexpensive Brickwork for Foundations. : Low Cost of Erection.

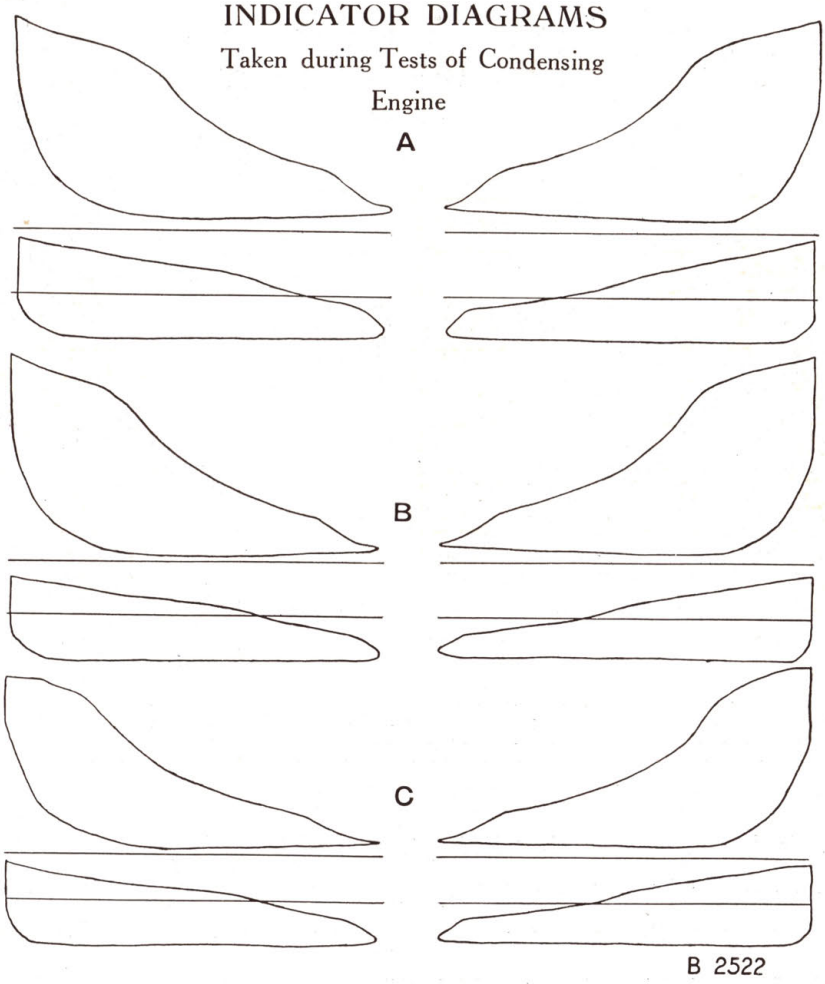
Results obtained on Works Tests of a Marshall No. 8 "Locomobile"

Test Data	Worked Condensing	Worked Non-Condensing
Duration of test	4 hours 50 mins.	2 hours 17 mins.
Temperature of feed	121° Fah.	190° Fah.
Superheat	155·6° Fah.	172° Fah.
Vacuum	27 inches	—
Revolutions per minute	165	165
Brake horse power	307	241
MECHANICAL EFFICIENCY ..	95·7%	94·5%
FUEL CONSUMPTION	*1·39 lbs. per B.H.P.	1·7 lbs. per B.H.P.
Calorific value of coal	*11,500 B.T.U.'s per lb.	11,500 B.T.U.'s per lb.

*N.B.—*It will be noted that the calorific value is not of high quality, and the actual consumption referred to coal of, say, 14,500 B.T.U's, is a very low one (i.e. 1·1 lbs. per B.H.P. worked condensing).*

INDICATOR DIAGRAMS

Taken during Tests of Condensing Engine



A. Maximum Momentary load, 350 B.H.P. B. Maximum Continuous load, 310 B.H.P. C. Normal load, 250 B.H.P

The Coal Consumption per Brake Horse Power was constant at Normal and at Maximum Continuous loads.

SCALE OF DIAGRAMS :—High Pressure Cards : 164 lbs. per inch. Low Pressure Cards : 50 lbs. per inch.

"MARSHALL" LOCOMOBILES, SERIES "C"

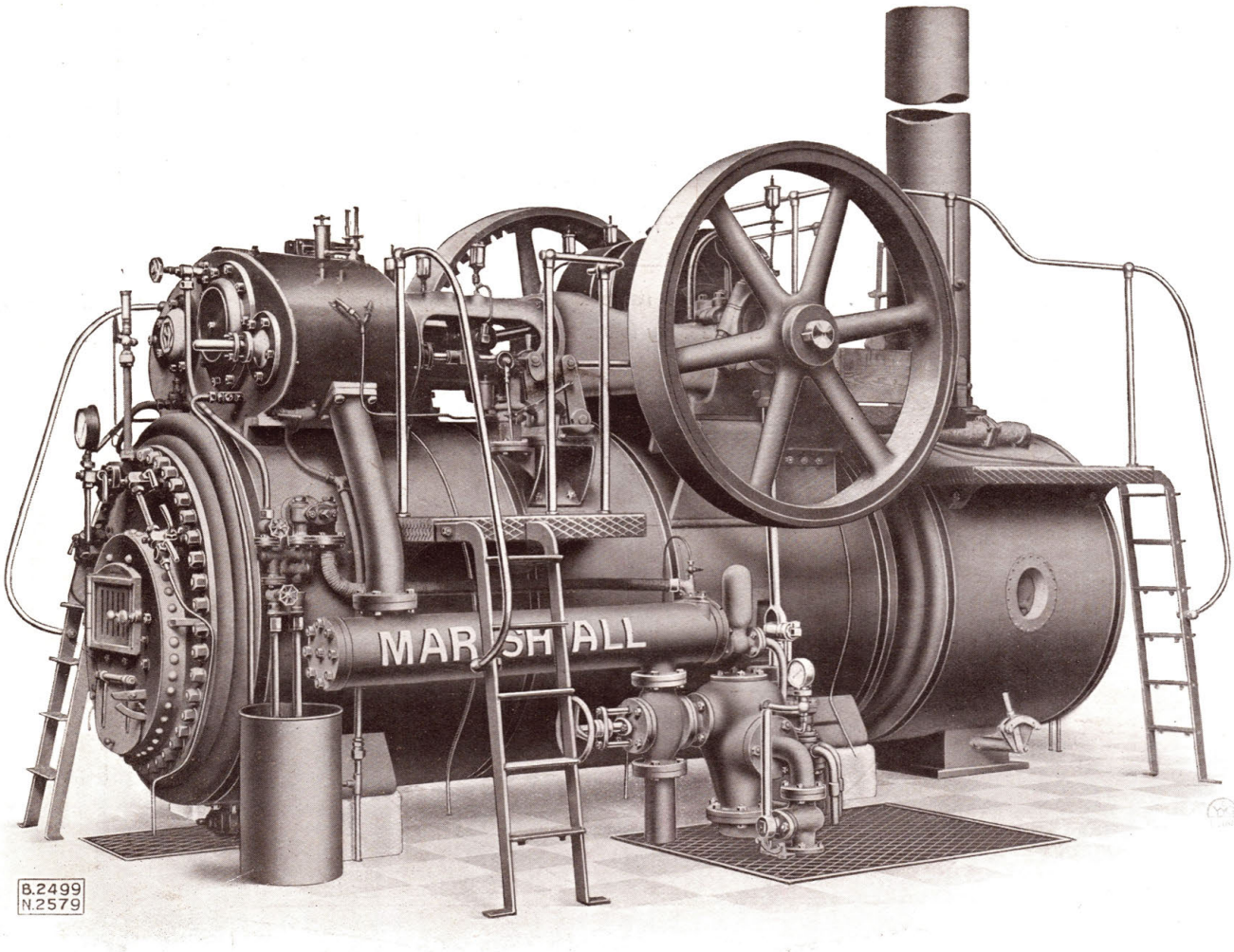


Illustration of a Marshall "Locomobile," Symbol C1, Ordinary Firegrate, to develop 50 B.H.P. normal load and 65 B.H.P. maximum continuous load.

"Locomobiles" are largely installed for central station work. Electrical engineers prefer them on account of their reliability, flexibility and steady running, which are highly essential factors for the generation of electricity for light and power, and, what is of the highest importance, the low switchboard costs which "Locomobiles" make possible.

"MARSHALL" LOCOMOBILES, SERIES "C"

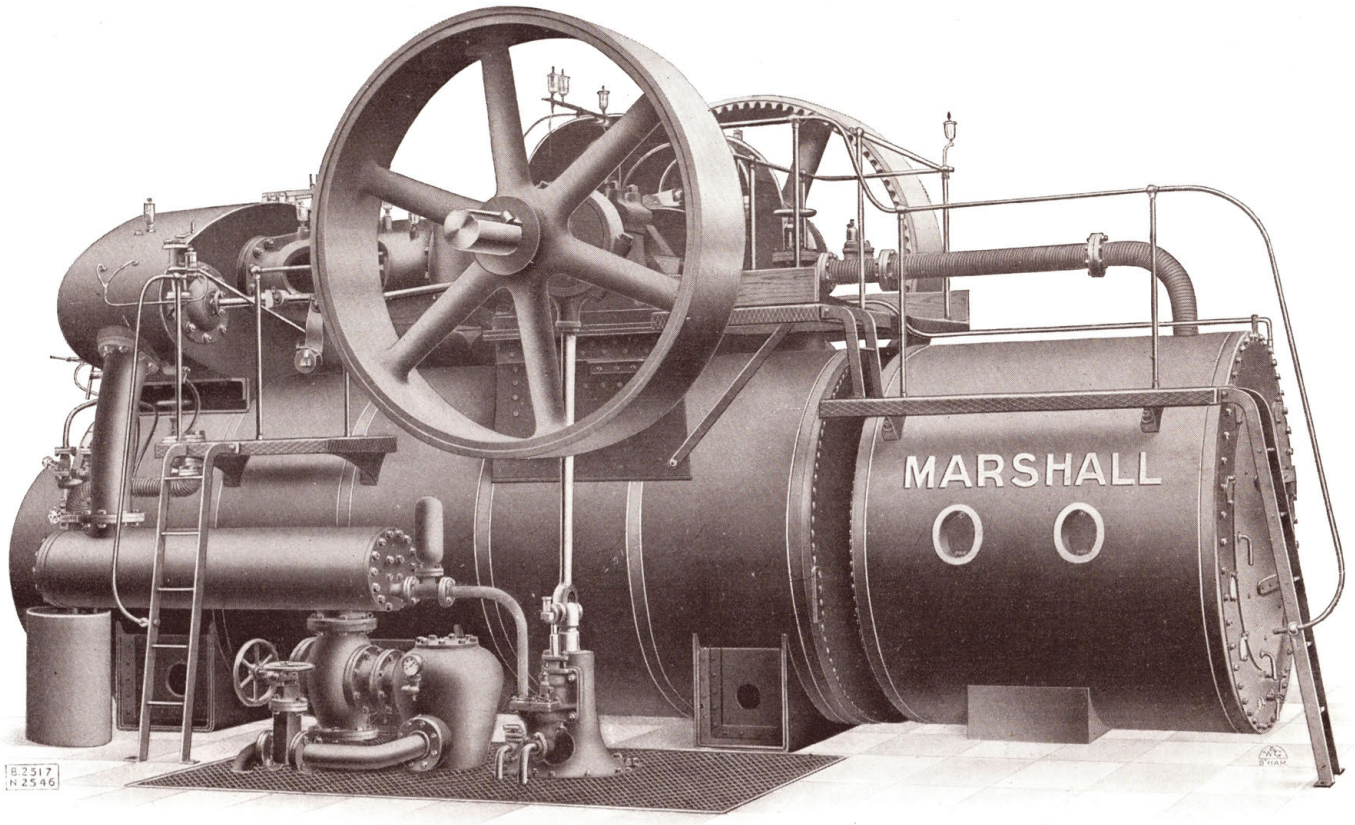
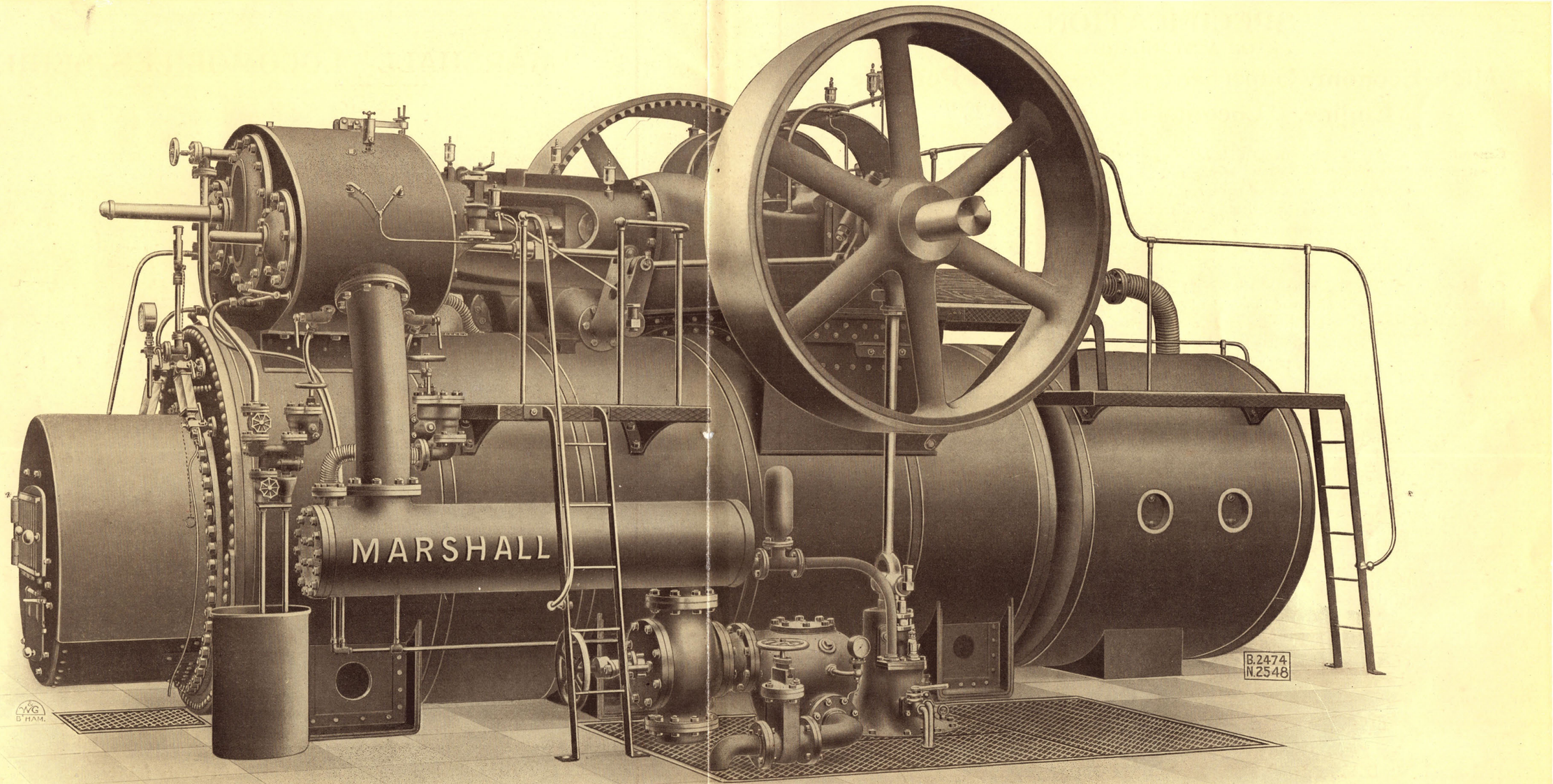


Illustration of a Marshall "Locomobile" Symbol C8, to develop 250 B.H.P. normal load and 310 B.H.P. maximum continuous load.

These Engines are also admirably adapted for power purposes in :—

Flour Mills, Saw Mills and Wood-working Factories; Dairies, Distilleries, Breweries, Sugar Factories; Brickyards, Cement Works, Tarmacadam Works; Paper and Pulp Mills; Printing Works, Rubber Mills; Textile, Spinning and Weaving Mills, Pumping for Town Water Supplies, Irrigation, Drainage and Sewage Disposal; Iron and Steel Works, Quarries, Mines, Collieries, Engineering Works, and other Industrial Installations.



"Marshall" Superheated Steam Semi-Portable Engine. (Symbol C8). "Locomobile" Series.

Power Output :—Normal, 250 B.H.P. Maximum Continuous, 310 B.H.P. Maximum Momentary, 350 B.H.P.

The furnace has the short extension firegrate, as used for inferior coal and hard woods.

SPECIFICATION
OF A STANDARD
High-Economy Superheated Steam Semi-Portable Engine, "Locomobile" Class "C"

General Construction

As will be seen from the illustrations on pp. 16 to 19, this Engine is of the **Semi-portable Side-by-Side Compound arrangement** superimposed on a cylindrical **tubulous Boiler,** occupying minimum floor space, requiring only light foundations, and provided with every facility for examination, cleaning and economical working.

The arrangement is compact, massive and substantial in construction; and devised so that the attendant may easily maintain full supervision over the whole plant.

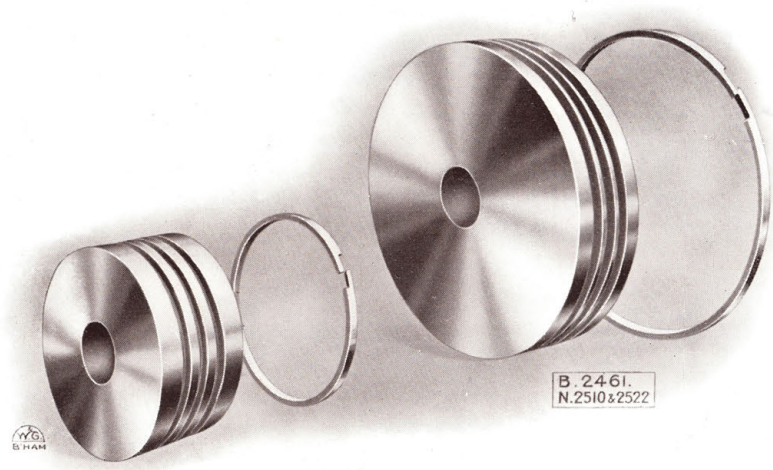
Cylinders, Pistons and Piston Rods

The Engine has the **High and Low Pressure Cylinders** combined in a casting made of a special mixture of close-grained cast iron of as equal a thickness as possible throughout. The working barrels are separate castings, pressed into the main casting.

The Cylinder casting has a flat **planed** base and is mounted on wrot-steel brackets with planed upper surfaces riveted to the Boiler shell. No connecting bolts enter the steam space of the Boiler.

The Valve Chests are cylindrical chambers incorporated in the cylinder casting, and arranged with short steam ports giving minimum waste spaces for clearance steam. The steam chests are provided with separate liners for the piston valves to work in.

The boring of the cylinder and the valve chests is most carefully done, and perfectly smooth working surfaces for the valves and the pistons are thereby ensured.



PISTONS & PISTON RINGS

The High and Low Pressure Pistons are made of cast iron of as equal weight as possible, so as to be in balance when running. Each piston is truly ground to size, polished on both faces to minimise clearance volume and promote economy, and fitted with steam-tight spring rings of the "Ramsbottom" pattern with special joints.

The Back Covers are turned and polished, and fitted with false covers for checking radiation loss. The front covers contain the piston rod stuffing boxes, and are placed between the cylinder casting and the flanges of the bored guides. **The Bored Guides** are massive

Specification (continued)

cylindrical castings rigidly connecting the cylinder casting with the crankshaft carriages, and containing the tooled paths for the crossheads.

The Stuffing Boxes are arranged to receive "**Labyrinth**" **pattern metallic packings.** These packings are capable of withstanding the high steam temperature employed, and they ensure steam-tight piston rods with minimum friction and the least trouble in attendance.

The Piston Rods are of specially selected mild steel. They are accurately ground to size, and provided with cone ends where fitted into the pistons and crossheads.

Motion is conveyed to the piston valves through rocking arms which are supported on suitable cast iron brackets.

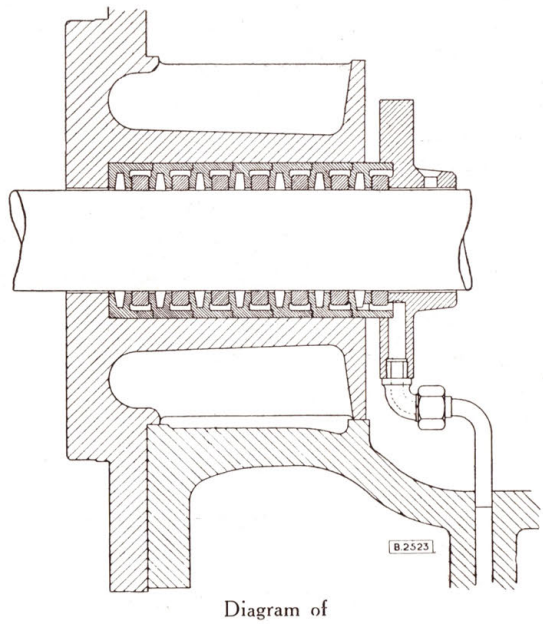
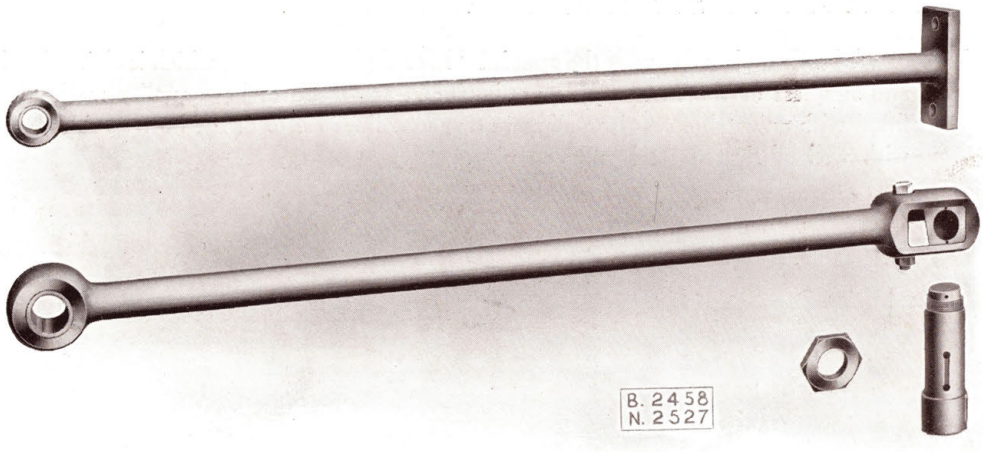


Diagram of
"LABYRINTH" PACKING.

The Steam Distribution Valves are of the piston type, made as light as possible consistent with strength, accurately ground to fit the cylindrical steam chests, and provided with carefully designed and fitted spring rings which ensure steam-tightness and absence of leakage when working. Being perfectly balanced and working with very little friction in the steam chests, the smallest



VALVE ECCENTRIC RODS

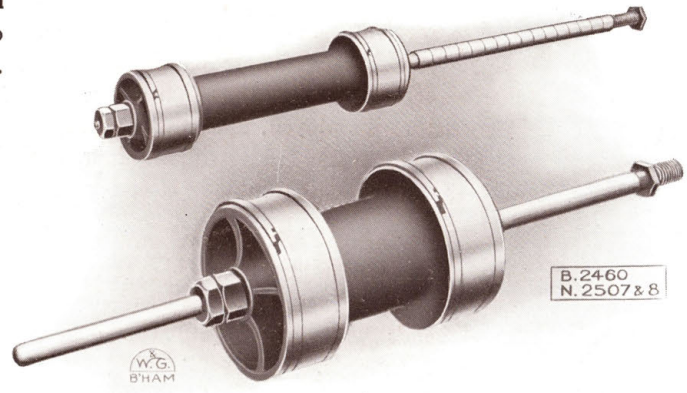
amount of force is absorbed by the valve mechanism, and the mechanical efficiency of the engine is greatly enhanced.

The High Pressure Piston Valve is worked by an eccentric controlled by a centrifugal governor mounted on the crankshaft of the engine. The governor is connected directly to

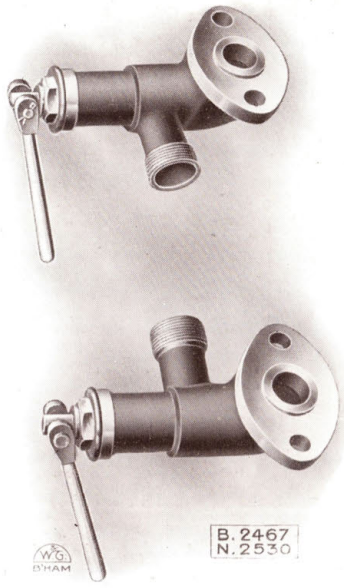
Specification (continued)

the eccentric sheave, and as there are no joints to cause lost motion, so the governor is sensitive, prompt and powerful enough to control and maintain a steady speed of the engine.

The Low Pressure Piston Valve is worked from the air pump eccentric through a rocking motion.



PISTON VALVES

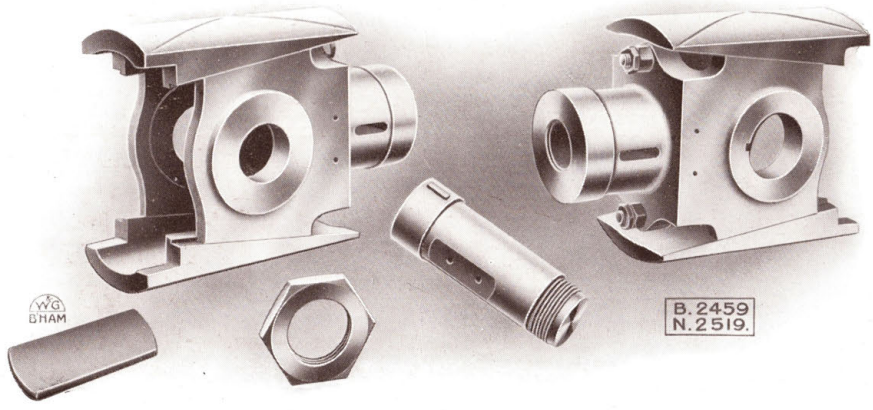


COMBINED DRAIN & RELIEF COCKS

Suitable cylinder drain cocks and water escape valves are provided. The cylinder exterior is effectively lagged with non-conducting composition to prevent radiation losses.

Superheated steam is conveyed from the superheater by means of a well-insulated steam pipe carried along the top of boiler to the steel stop valve which is attached to the front of the cylinder and communicates with the central chamber of the high-pressure piston valve steam chest.

Crossheads. **The Crossheads** are of the **special " Marshall " pattern,** which is claimed to be the best and simplest of the many types used. They are made of best quality malleable iron, and fitted with adjustable cast iron slippers turned cylindrical to fit the bored guides, and provided with well-lubricated steel gudgeon pins.

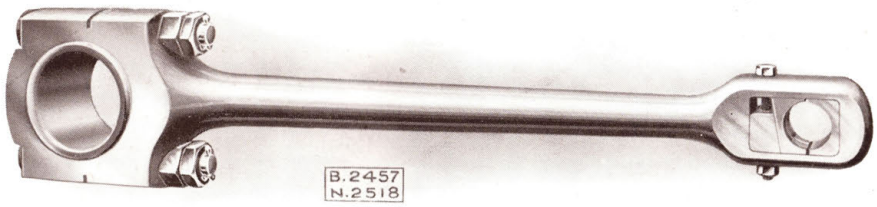


CROSSHEADS

Specification (continued)

Connecting Rods

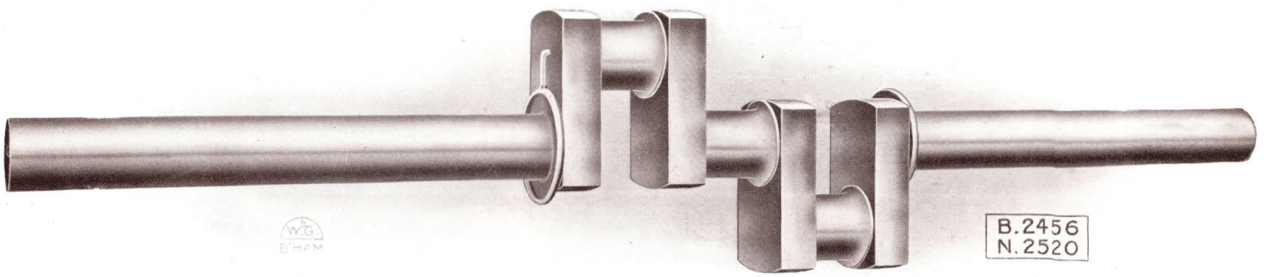
The Connecting Rods are of best mild steel, of the " marine " pattern, turned and polished, and fitted with large adjustable gunmetal bearings at each end. The adjustments are arranged to maintain a constant length of rod.



CONNECTING ROD

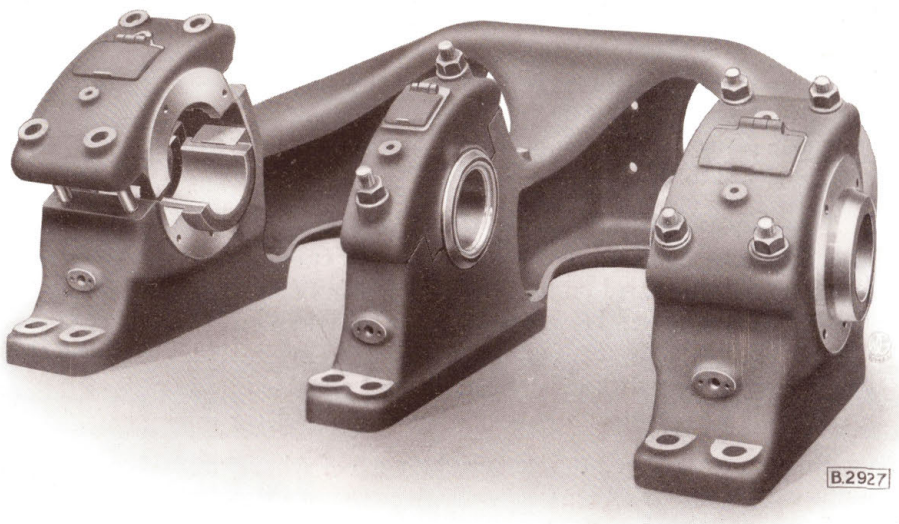
Crankshaft and Bearings

The Crankshaft is of the square-jaw double-throw type, made of high-class mild steel, of very solid construction and ample strength. It is forged in one piece from a specially-selected ingot, machined carefully all over and accurately bedded into the three crankshaft bearings.



CRANKSHAFT

The Crankshaft Carriages are of the " Marshall " special design with angle pedestals.



CRANKSHAFT CARRIAGES AND BEARINGS

Specification (continued)

The bearings are substantial malleable castings lined with best bearing metal, and of extra length to ensure liberal surfaces for the crankshaft.

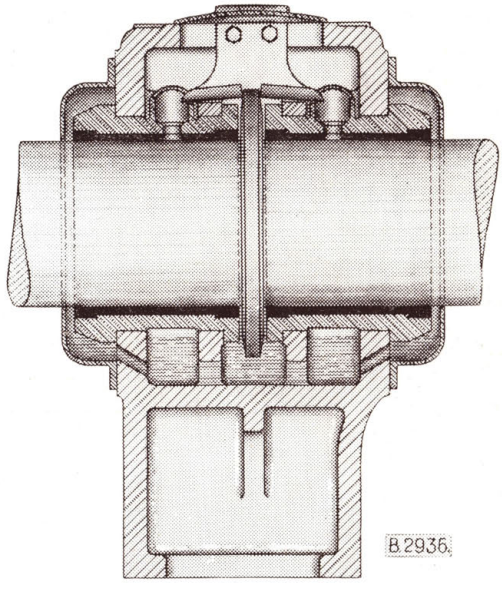


DIAGRAM OF CRANKSHAFT BEARING

The lubrication of the crankshaft bearings is effected by means of **Automatically-revolving Rings,** which, as the crankshaft rotates, lift the oil from wells formed in the pedestals. The oil is distributed over the whole length of the bearings, and is carried back to the oil well and used again. The crank wells will contain sufficient oil to run a month, or longer, without replenishment.

Openings are provided in the pedestal caps so that the oiling rings may be easily inspected. The lubrication is continuous and there is no waste. Suitable arrangements are made for draining off the spent oil and refilling the wells, and a sight-level is provided.

The crank carriages are supported on the Boiler by **a strong steel platform with planed surface** and arranged so that the expansion of the Boiler is compensated in such a way that the length of the engine centres and the clearances in the cylinders are unaffected. This arrangement is a decided improvement upon designs where the crankshaft brackets are rigidly attached to the boiler.

FLY-WHEEL BARRING GEAR

Fly-wheels

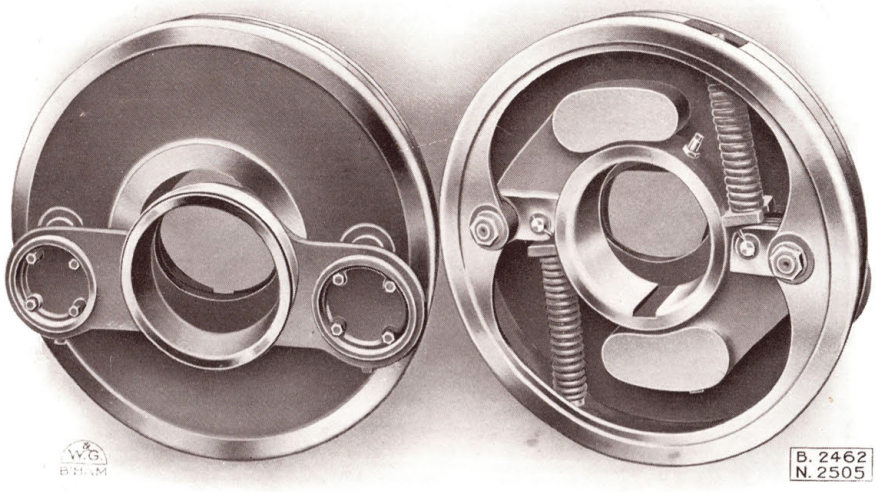
Two Fly-wheels, of suitable weight to ensure regularity of running, are mounted one on each end of the crankshaft, turned on the faces for receiving a driving belt, the power being usually taken off the left-hand fly-wheel when looking at the engine from the firing end. This fly-wheel is provided with a suitable barring rack, so that the engine may be conveniently brought into starting position by the lever barring gear.

The fly-wheels are set to rotate with the top of wheels turning **away** from the cylinders, but the engines can be set for the fly-wheels to run in the opposite direction if we are notified to this effect at the time of order.

Specification (continued)

Governor and Valve Gear

A Centrifugal Crankshaft Governor is provided, automatically controlling the eccentric which works the Piston Valve of the high pressure cylinder, so as to ensure that the steam is used in exact proportion to the duty required from the engine. The Piston Valve of the low pressure cylinder is driven from the crankshaft through the air pump eccentric, and arranged to cut off the steam to suit the average load on the engine. All parts of the valve motion liable to wear are fitted with case-hardened steel pins and bushes.



CRANKSHAFT GOVERNOR

Lubricating Appliances

Throughout the Engine the **system of lubrication** is designed to be thoroughly effectual without waste of oil. The crankshaft bearings are continuously lubricated by Automatic Oilers, and require very little attention.

The crank pins are lubricated by centrifugal oiling rings which supply oil to drilled channels in the crank pins.

The cylinders are lubricated by special forced feed lubricators. Oil suitable for high pressure steam must be supplied to the cylinders. The quantity can be exactly regulated, and the oil pumps are fitted with a mechanical device for injecting an extra quantity of oil into the cylinders for starting and when other occasion requires.

All other working parts have lubricators which can be refilled whilst the engine is running, and all are adjustable so as to feed a regular supply. When the engine is stopped, all feeds can be closed. By this means the quantity of oil, whilst sufficient for smooth running, is used in the most economical manner.

Feed Pump

See Illustration on page 26.

The Feed Pump is fixed to the Air Pump Casting and is worked by the same eccentric. It has a cast iron body with gunmetal plunger, valves and seatings. This pump always draws a full charge. A feed control cock is fitted to the pump delivery whereby a portion of the charge is returned to the suction side and the remainder passed into the Boiler. Thus the supply can be regulated according to the load on the engine so that a constant water level may be maintained.

A gunmetal check valve is fixed on the Boiler. A suitable relief valve and air vessel are fitted to the pump.

Specification (continued)

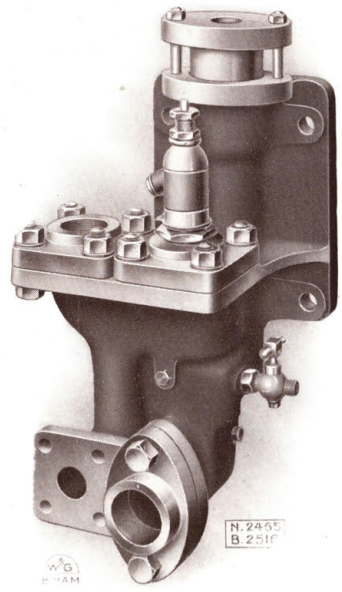
Injector

An Automatic-positive Injector is fitted as a duplicate feed for the Boiler. The Injector is made of high-class gunmetal, fitted with steam and suction valves, and pipe connections, and coupled direct to a check valve on the Boiler.

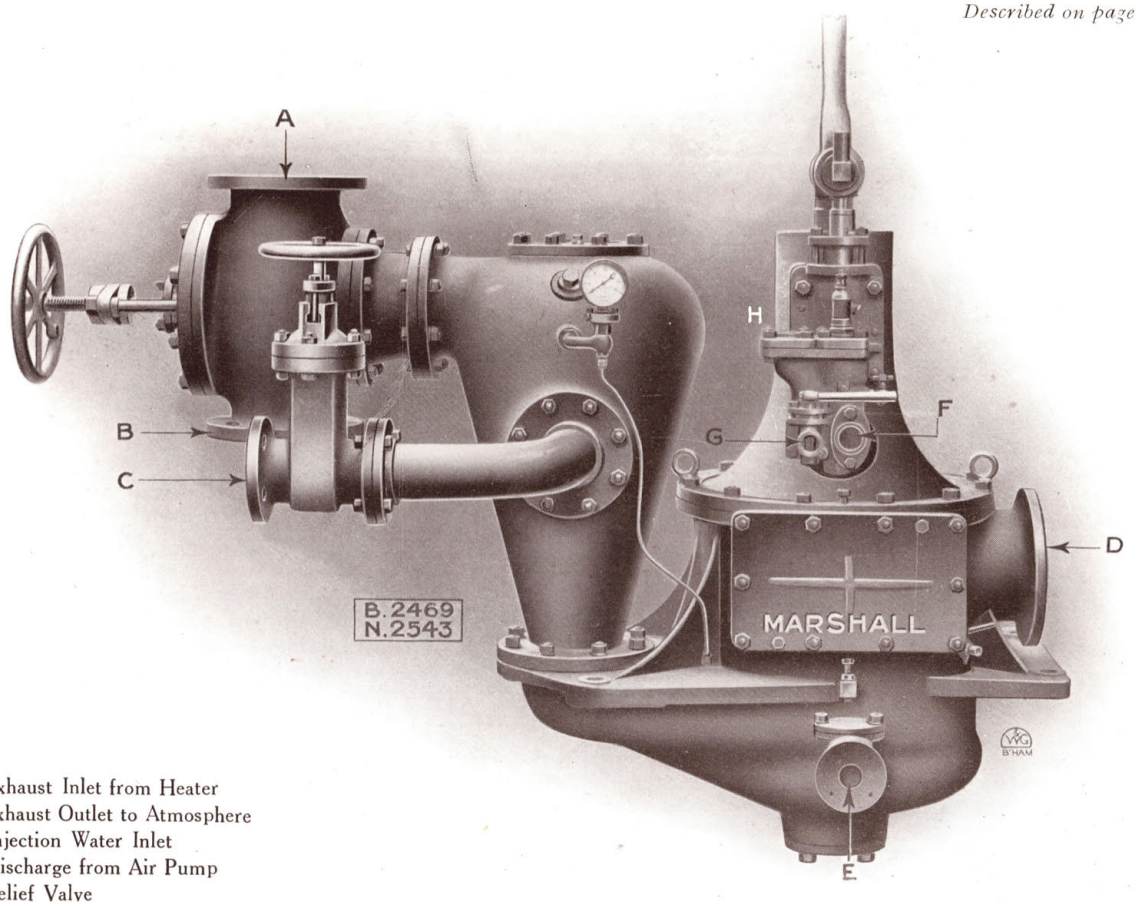
The check valves for the injector delivery and the feed pump delivery are fitted with cocks interposed between the valves and the boiler, so that the latter can be safely shut off should occasion arise, and the valves examined and cleaned whilst the boiler is under steam.

Feed Water Heater

This apparatus is of the **horizontal "multiflow" type.** It consists of a cast iron cylindrical chamber with a series of internal brass tubes expanded in tube plates at each end of the heater. The delivery from the feed pump is passed through the tubes of the heater, and the tubes are surrounded by exhaust steam passing from the low pressure



FEED PUMP
Described on page 25



A. Exhaust Inlet from Heater
B. Exhaust Outlet to Atmosphere
C. Injection Water Inlet
D. Discharge from Air Pump
E. Relief Valve
F. Feed Pump Suction
G. Feed Pump Overflow
H. Feed Pump Delivery

CONDENSER AND AIR PUMP
Also shows Feed Pump in position.

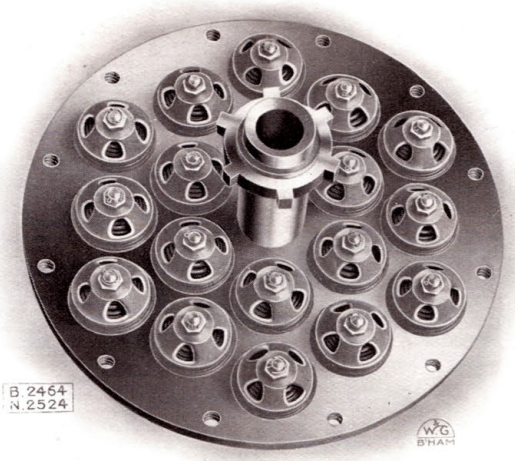
Specification (continued)

cylinder to the condenser. The water thus acquires a considerable increase of temperature and the boiler derives all the advantages of a pre-heated feed.

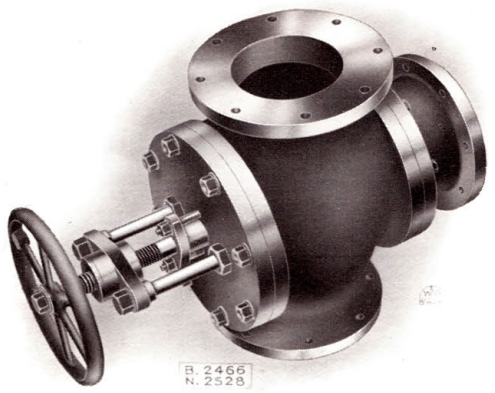
Jet Condenser and Air Pump

A Jet Condenser and " Edwards " type Vertical Air Pump are supplied to condense steam and maintain a good vacuum with sufficient supply of condensing water. The required quantity of condensing water varies from 30 to 40 times the quantity of steam condensed according to the temperature of the water.

This type of condenser is more efficient than the horizontal type. The air and condensed steam are rapidly got rid of by the " Edwards " type air pump.



AIR PUMP VALVES



THREE-WAY VALVE TO ENABLE "LOCOMOBILE" TO WORK NON-CONDENSING

The Air Pump is fitted with gunmetal liner and bucket and metallic delivery valves. An access door is provided for getting at the delivery valves. The pump is worked by an eccentric on the engine crankshaft.

See also pp. 32 and 33 for other arrangements of Condensers.

Boiler

The Boiler is of the **cylindrical tubular type** internally-fired, and of ample strength and suitably stayed **for a continuous working pressure of 180 lbs. per square inch.** The materials used are the best procurable. The plates are Siemens-Martin mild steel, shaped and wrought on the most advanced principles of boiler construction. All flanged plates are specially selected, our press work is correct in design and execution, and the fitting together of the boiler plating is comparable only with the machined fits of the engine.

The plate thicknesses, the staying and the riveting are calculated to satisfy the demands of the highest Official Authorities controlling boiler construction, including the British Board of Trade, and the principal Boiler Insurance Companies. There is everywhere a liberal margin over what the Authorities require for boilers working at a pressure of 180 lbs. per square inch.

The shell plates are cold rolled in true cylindrical form, and this form is very carefully maintained throughout the manufacture of boiler.

All plate edges are **planed and squared.**

All rivet holes are **drilled** with the plates in position, and there are no drifted holes. The arris due to drilling is removed before riveting.

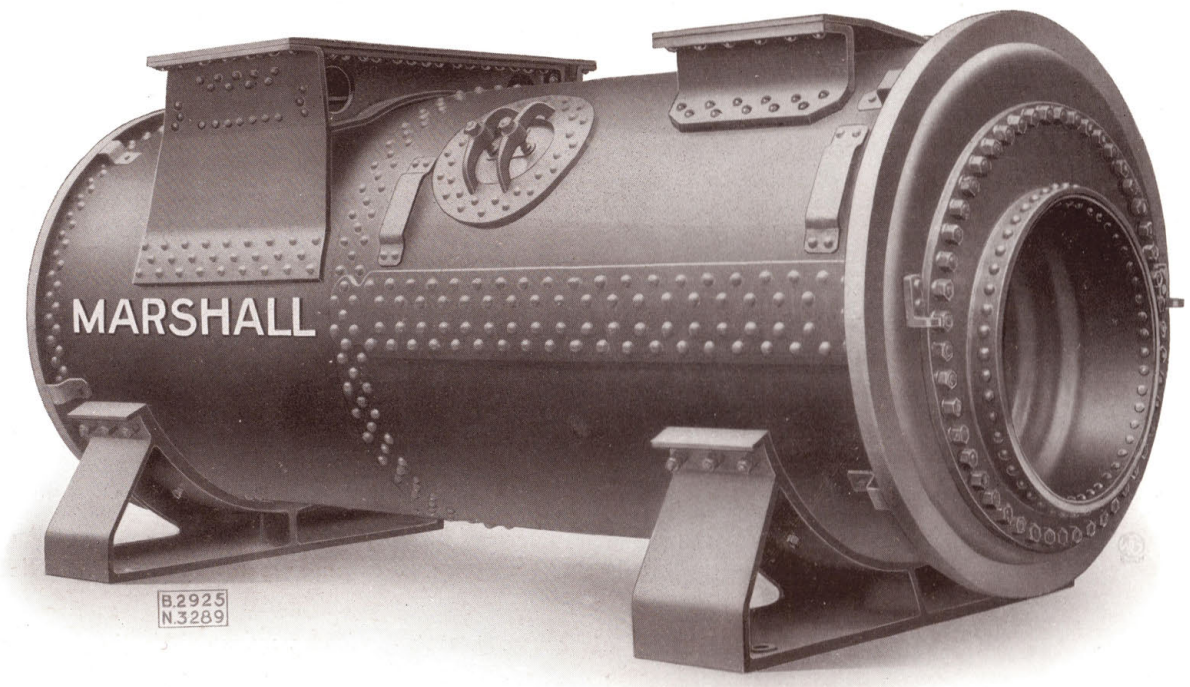
Specification (continued)

All riveting is done by powerful hydraulic machinery. The pitches of the rivets and the efficient caulking of the seams ensure steam-tight and water-tight joints under the extreme test pressures.

The seams in the shell are strapped with double butt straps and double-riveted, and the circumferential seams are also double-riveted.

The flue and the fire-tubes form a **separate unit.** This unit is bolted to the shell of boiler in such a way that it can be withdrawn, when required, in order to remove scale from the interior surfaces of the boiler.

The flue is cylindrical, corrugated for large, and plain for small sizes. The front of the flue is provided with a strong angle ring for bolting up to the front plate of the boiler. The back of the flue is closed by a flanged tube plate.



"LOCOMOBILE" BOILER, SHEWING SEATINGS FOR FOUNDATIONS AND ENGINE

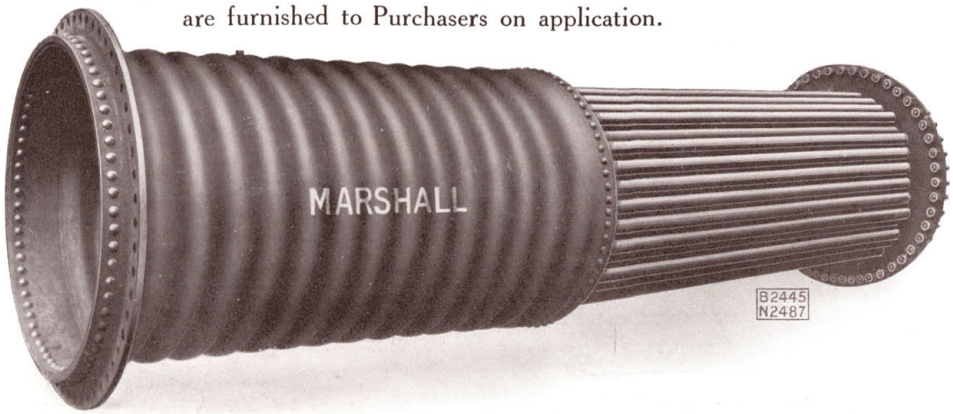
The fire-tubes are of the best quality, ferruled, and securely expanded in the two tube plates. A sufficient number of stay-tubes of extra thickness is provided and screwed into the tube plates. The fire-tubes are placed sufficiently far apart, so that when the flue unit is withdrawn, the tubes can be satisfactorily freed from scale by means of scaling chisels.

The smokebox tube-plate and the front angle ring of the flue are properly faced, and drilled for studs and bolts of close pitch to ensure that a thoroughly tight joint can be made on the end plates of the boiler.

Liberal heating surfaces are provided in the boilers so that they can **generate ample steam for the maximum continuous load.** The balance of heating surface of boiler and of superheater is, however, taken into consideration, so that the proper amount of superheat is obtained in order to secure the most economical fuel consumption.

Specification (continued)

Suitable brackets are fixed to the boiler shell for supporting the "Locomobile" on its foundations. Certificates of strengths of materials used and the tests of the boiler are furnished to Purchasers on application.



WITHDRAWABLE TUBE UNIT FOR "LOCOMOBILE" BOILER

Boiler Fittings & Mountings

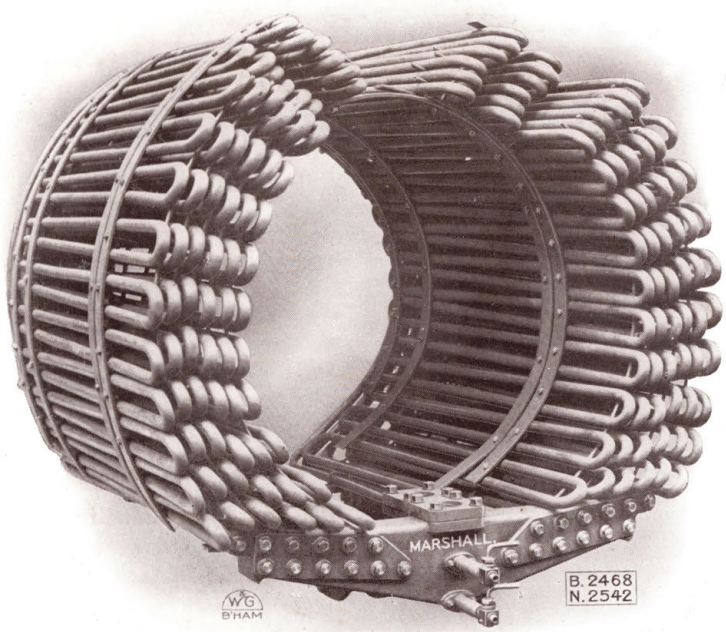
Our Standard Engines are provided with a wrought steel furnace front, with firedoor, air grids, cast iron bridge and dead plates, and a set of grate bars suitable for burning good coal as fuel. The flue is sufficiently long to enable us to provide longer grates when required for inferior fuels. **Extensions to the furnace can also be supplied when such combustibles as wood, brown coal, sawdust, bagasse and other fuels of low calorific value are to be used.** *See also Pages 34 and 35.*

The Boiler Mountings comprise a gland-packed blow-off cock, two sets of water gauge fittings with guards, and automatic stop valves to shut off the cocks if the gauge glass breaks, water level indicator, steam pressure gauge with syphon, spring balance double safety valve, and fusible safety plug fitting. These fittings are of the most approved type and first-class construction in every detail.

Superheater

The Superheater is arranged in the smokebox at the end of the boiler in such a way that the boiler fire-tubes are entirely accessible for cleaning with the tube brush. This is an important feature, for the cleaning of fire-tubes by means of a steam jet is not always satisfactory under certain conditions of fuel and firing.

The superheater consists of a series of solid-drawn steel tubes, arranged in zig-zag fashion round the space inside the smokebox, and clear of the boiler tubes.

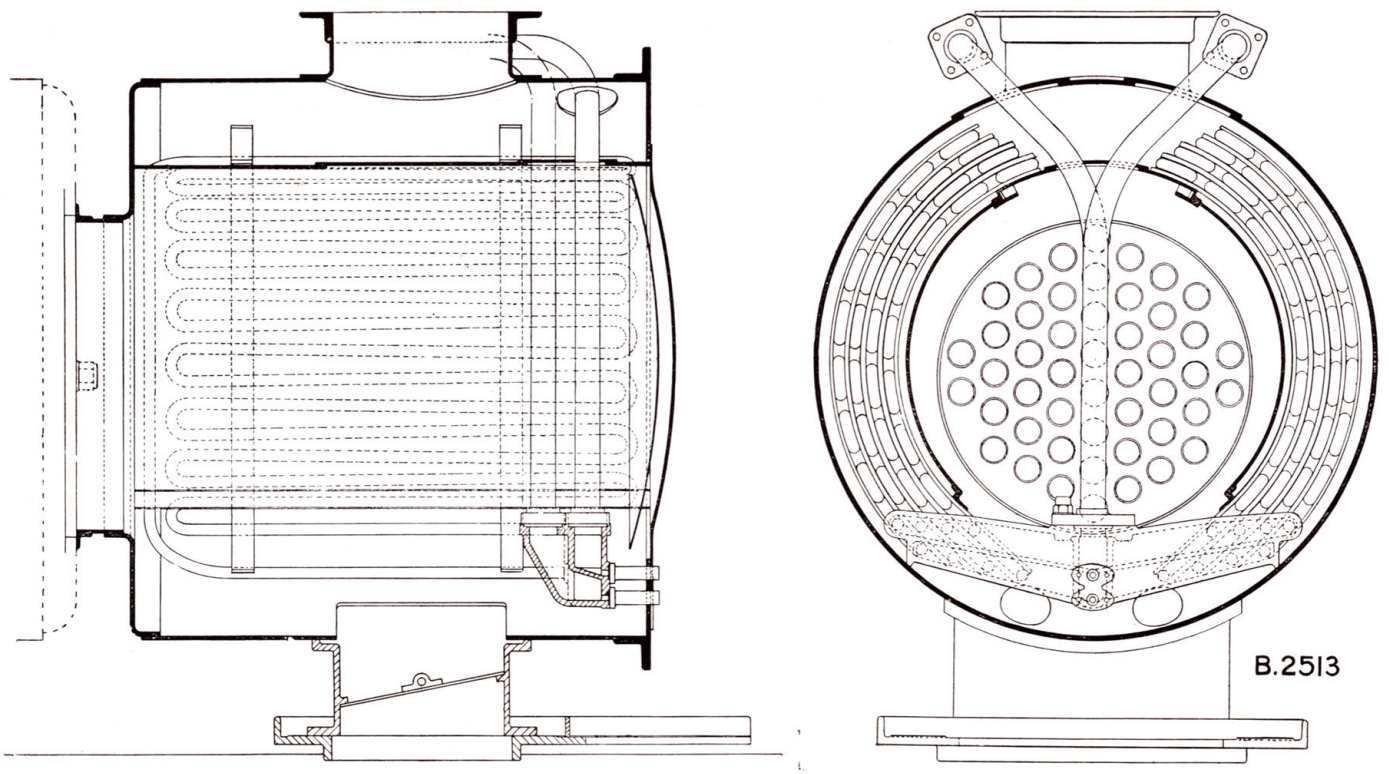


"LOCOMOBILE" SUPERHEATER

Specification (continued)

The ends of the tubes are brought together into a cast steel divided header, which is placed at the front of the smokebox, at the bottom. This arrangement is a great improvement over other types of superheaters, inasmuch as all the joints, both of the superheater tubes and of the pipes for saturated and superheated steam, are readily accessible. The header is also provided with cocks for completely draining the superheater, so as to remove all risks from the presence of water in the coils.

The steam current through the superheater is always arranged on the counter current principle, whether the gases are taken out of the top of the smokebox or out of the bottom. The disposition of the superheater tubes provides a " hit and miss " arrangement, which breaks up the streams of hot gases from the boiler and secures the maximum transmission of heat between the gases and the steam.



GENERAL ARRANGEMENT OF SUPERHEATER.

Ample provision is made for keeping clean the superheater tubes, and this is an important feature, as deposits of dust and soot on the tubes impair the efficiency of the heat transmission.

When getting up steam, the gases can be discharged to the chimney without passing over the superheater tubes. This is done by means of a sliding damper. With uptake or down-take, the device is equally effective. Thus there is no risk of damage to the tubes when steam is not flowing through them, and they can be kept in a much cleaner condition than when the gases are at all times passed over the superheater tubes on the way to the chimney.

A valve is provided to shut off the superheater from the boiler when required ; also a safety valve, drain cocks and thermometer pocket.

Specification (concluded)

There are designs of superheaters in which the exhaust steam from the high pressure cylinder is superheated on its way to the low pressure cylinder. The advantage of such an arrangement is small, and besides the added complication, there is the disadvantage that lubricating oil is carried into the superheater with deleterious effect. We prefer to superheat clean steam from the boiler, maintaining the superheat as far as possible into the low pressure cylinder.

Lagging

The whole of the boiler shell is covered with non-conducting composition enclosed with wood lagging and sheet iron and the necessary bands ; the smokebox is covered with a non-conducting composition of sufficient thickness to prevent radiation ; and the cylinder and feed water heater are thoroughly well lagged with non-conducting composition covered with sheet steel.

Accessories and Spares

The compact arrangement of Engine and Boiler allows every provision to be made to meet the convenience of the attendant. Steel ladders with flat treads are supplied to reach the steel chequered plate platforms from which the motion work of the engine can be easily examined. Standards and hand rails are also fitted to ensure safety. Splash guards and oil catchers promote cleanliness. The equipment includes lifting hooks, tool box, hammer, chisels for scaling, spanners, firing tools, shovel, tube rod, tube brush, steam blower jet for cleaning fire-tubes and superheater, oil feeder, water funnel and spare gauge glasses. Spare oiling rings for crankshaft bearings, piston valve rings, cone for fusible plug, metal rings for piston rod packings, jointing rings and jointing material are supplied without extra cost.

Testing

Our " Locomobiles " are thoroughly **tested under steam at our Works** and run sufficiently long to ensure that all working parts are accurately adjusted and thoroughly satisfactory. (The boilers are independently tested under hydraulic pressure to 280 lbs. per square inch before being combined with the engines). Indicator diagrams are taken at different loads and the valve mechanism is carefully adjusted to give the best and most economical results in working. Purchasers hereby have assurance that the engines will be satisfactory when properly installed at destination.

It is desirable that all engines should be periodically overhauled and indicator diagrams taken to see that the best possible distribution of steam is maintained. For this purpose we can supply the necessary cocks and appliances, with or without the indicating instrument, as may be preferred. A moderate extra charge is made for these appliances.

Drawings & Foundations

Drawings necessary for setting out the installation are furnished by us. No masonry, brickwork nor foundations are included in our Contracts. A comprehensive Instruction Book is given with every Engine.

Spares (additional)

The following additional spares are recommended as a complete outfit for a "Locomobile," particularly when the destination is overseas :

One set each Crankshaft Bearings, Connecting Rod Bearings, Piston Rings, Piston Valve Rings, Piston Rod Packings, Air Pump Valves, (if Condensing Engine) Feed Pump Valves, Feed Pump Plunger and joint. One set of spares for Injector (suction jet, delivery jet). One set of Gratebars, 12 Boiler Tubes and 24 Ferrules, three Tube Brushes, one Fusible Plug, 12 Gauge Glasses and 24 Rubber Rings, two " Durite " Rings for flue, one length Flexible Hose for cleaning Superheater tubes, one Blow-off Cock, three Brass Tubes for feed water heater and 12 Drop Feed Lubricator Glasses.

Any or all of the additional Spares can be supplied at moderate extra charges.

Condensers

ALL Users of Steam Engines are doubtless aware of advantages and economy to be derived from condensing the exhaust steam. By the addition of the condenser, assuming a sufficient water supply is obtainable, the consumption of fuel can be considerably reduced, or additional power may be obtained without increasing normal fuel consumption. The jet condenser already described is usually supplied with our "Locomobiles," and will draw its water 16 to 18 feet vertically.

Provision is made for exhausting direct to the atmosphere when desired. This is effected by means of a three-way valve in the exhaust pipe, and such method of working may occasionally be necessary owing to failure of water supply and other causes.

It is important that the boiler feed should be clean pure water, free from corrosive salts. With a **Jet Condenser** we presuppose a water for condensing purposes which is also suitable for boiler feed. We do not, however, recommend that the Boiler should be fed from overflow water from the air pump, on account of cylinder lubricant carried by the steam through the engine to the condenser. A preferable method is that the clean cold water is pumped by the force pump through the heater to the boiler.

In case, however, that only a supply of bad feed water is available for all purposes, **a Surface Condenser** should be used. In this type, the steam from the engine and the water for condensing do not commingle and the water of condensation can be used for boiler feed. This will be pure water, provided that an Oil Eliminator is used in conjunction with the Surface Condenser to extract the lubricant from the steam before it reaches the Condenser.

A small amount of water as pure and clean as possible is required to make up slight losses due to blowing off at the safety valve and blow-off cock. An additional pump is generally required to circulate the cooling water when a surface condenser is used.

In cases where the supply of water for condensing is limited, some arrangement for cooling it must be adopted so that it can be used over again. To this effect a **Cooling Tower** is recommended. The heated water from the air pump overflow is pumped to the top of the tower. It finds its way downwards over a series of distributing surfaces which break up the water into fine globules, or thin streams. A current of fresh air meets the falling water and extracts the heat from it, thus reducing its temperature sufficiently for using over again.

Cooling Ponds are also used for economising condensing water. A larger ground area is required for the pond than for the tower. The water is sprayed into the air through specially shaped nozzles and thus atomised. The heat is carried away by the air currents which are set up. The heated water is either pumped directly to the nozzles, or into a tank above the pond so as to create a hydraulic head. The engine air pump must not be used to pump the overflow water to either cooling tower or cooling pond.

Condensers (continued)

Surface Evaporative Condensers are sometimes adopted for condensing with limited supply of water and when ground space is restricted. They can be placed on a roof so as not to encroach on floor space, and they require a make-up of a small percentage of the total water pumped into the boiler. Their disadvantages are first cost and risk of leakage at the tube joints.

If the conditions of locality militate against the employment of the standard Jet Condenser, we shall be pleased to make our recommendations regarding the other types of condensers, so that the engine may be worked on the most economical system obtainable.

Steel Chimneys

Steel Chimneys can be provided. For the smaller sizes of engines, the chimney can be carried directly on the smokebox. For the larger sizes of engines, we recommend the chimney to be placed outside the building and the connection between it and the smokebox to be made by means of a downtake and underground flue.

These steel chimneys can often be made locally in accordance with drawings which we can supply. For "overseas" requirements, this is usually a cheaper arrangement than if shipped from our Works, but if desired, we can supply the steel chimney in suitable lengths, made to nest one in another to reduce freight expenses. In that case, we also supply the necessary wire guys, stretchers, base, etc., so that the chimney can be erected complete.

Spark Arresters

Where it is considered desirable that the chimney should be fitted with a **Spark Arrester,** we can supply suitable types for attachment to the chimney top. Except in very special cases, this safeguard is not required, because the Superheater itself acts as a very effective Spark Arrester.

Transport Equipment

To facilitate the road transport of Engines of the " Locomobile " class, we are prepared to supply suitable **travelling wheels, undergear brakes, etc.** for mechanical traction or animal draught.

Heating

Where steam is required for separate heating appliances, drying, cooking and other purposes, a certain amount of steam can be taken direct from a " Locomobile" Boiler for such service. The exhaust steam from a non-condensing engine is available for heating and warming buildings.

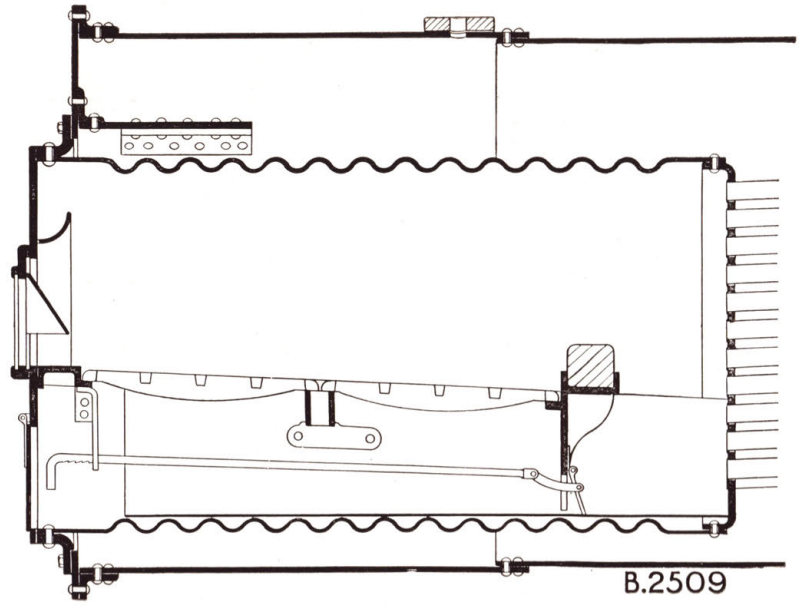
Furnaces & Firegrates for Marshall "Locomobiles"

Type
A

STANDARD FURNACE AND FIREGRATE

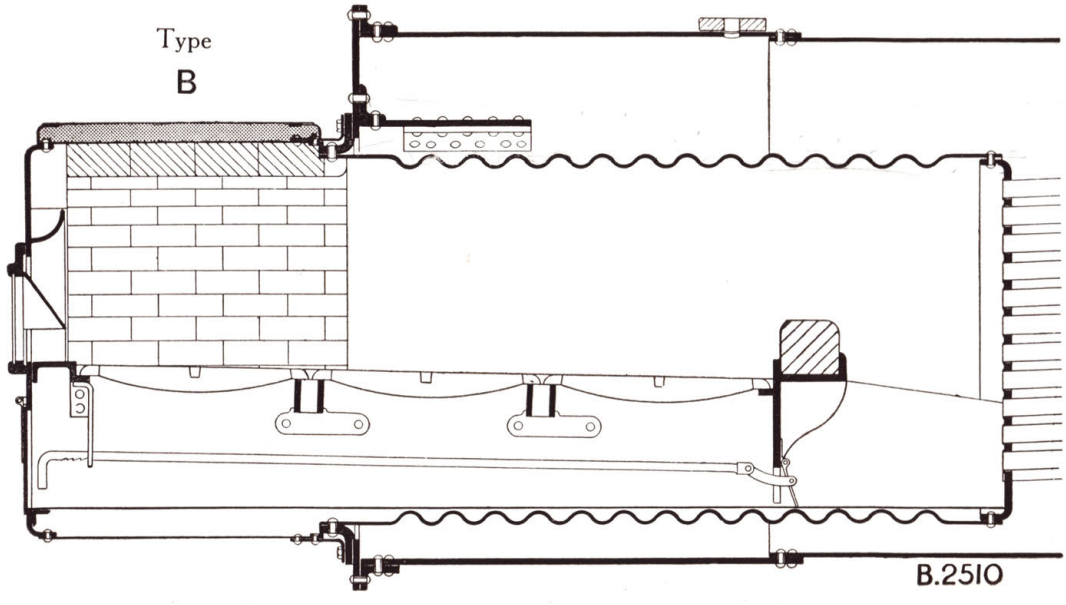
As used for good steam coal.

See illustration, page 16.



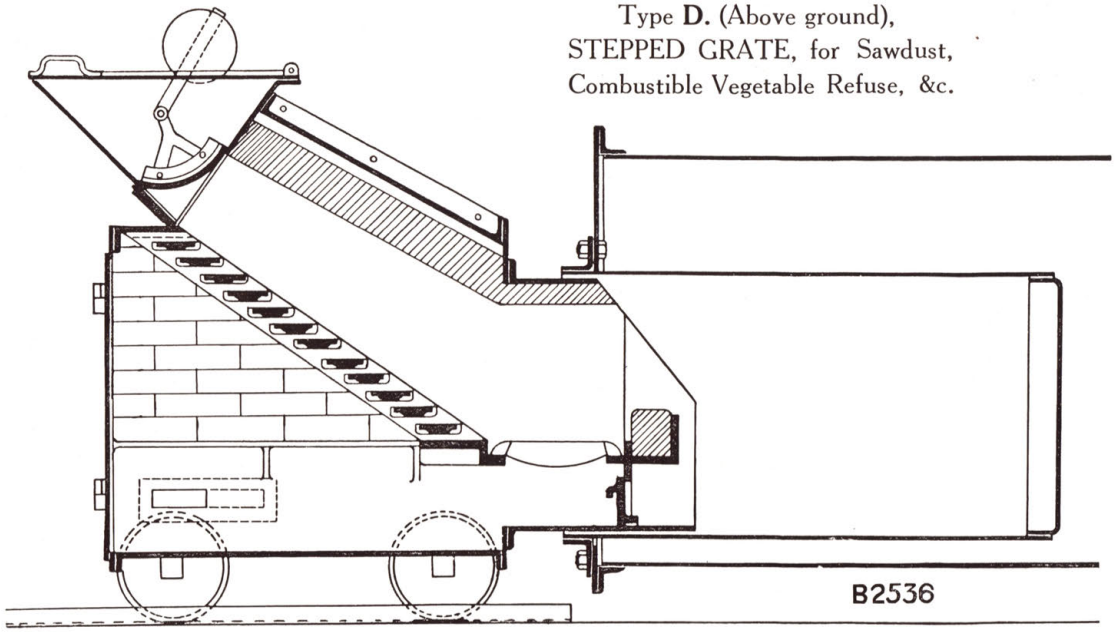
When it is known what class of fuel is to be generally used for firing the boiler, the " Locomobile " is supplied with a firegrate to suit that fuel.

Type
B



The lower illustration shews the arrangement of furnace extension and firegrate recommended when inferior coal and hard dry woods are the fuels available. An exterior view of this grate is given on page 18.

Type **D.** (Above ground),
STEPPED GRATE, for Sawdust,
Combustible Vegetable Refuse, &c.



The following types of firegrates are recommended :—

A. STANDARD GRATE. For good steam coal. See page 16.

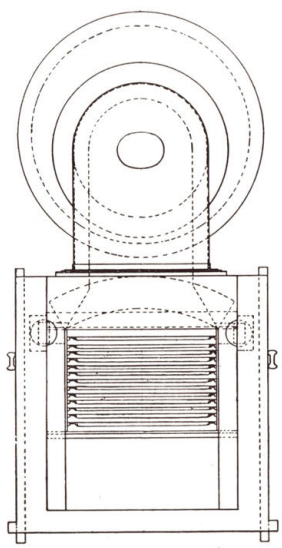
B. GRATE WITH SHORT EXTENSION. For inferior coals and hard dry wood. See page 18.

C. GRATE WITH LONG EXTENSION. For wood logs, large pieces of bark, sugar cane refuse (bagasse and megasse), maize stalks, brushwood, etc. (This is similar to type B).

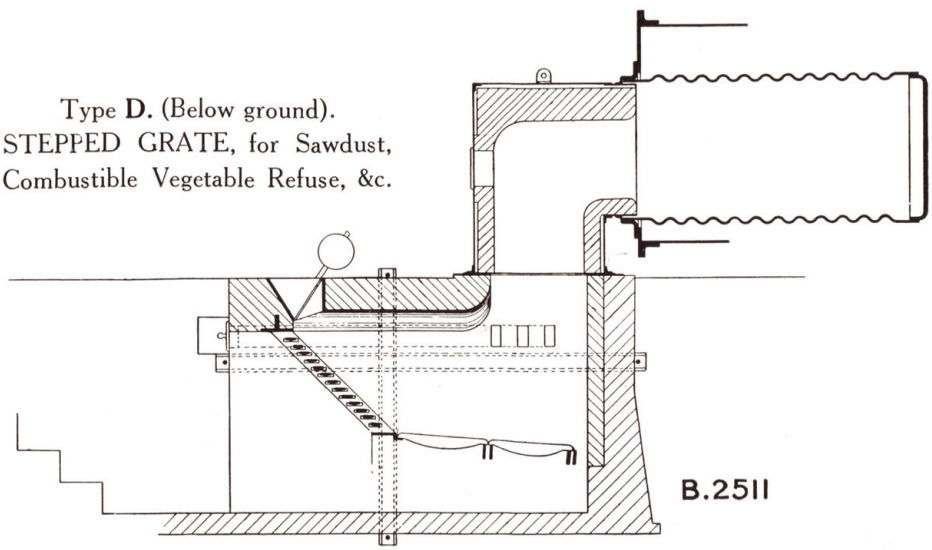
D. STEPPED GRATE. For sawdust, rice husks, coffee husks, flax shoves, etc. (this type of grate may be arranged either above or below the ground level, as desired). See illustrations.

E. LIQUID FUEL APPARATUS. Special appliances are required for feeding the furnace with petroleum, tar-oil, naphtha, etc.

F. MECHANICAL STOKER. Mechanically-operated automatic stokers can be fitted to the larger sizes of Marshall " Locomobiles."



Type **D.** (Below ground).
STEPPED GRATE, for Sawdust,
Combustible Vegetable Refuse, &c.



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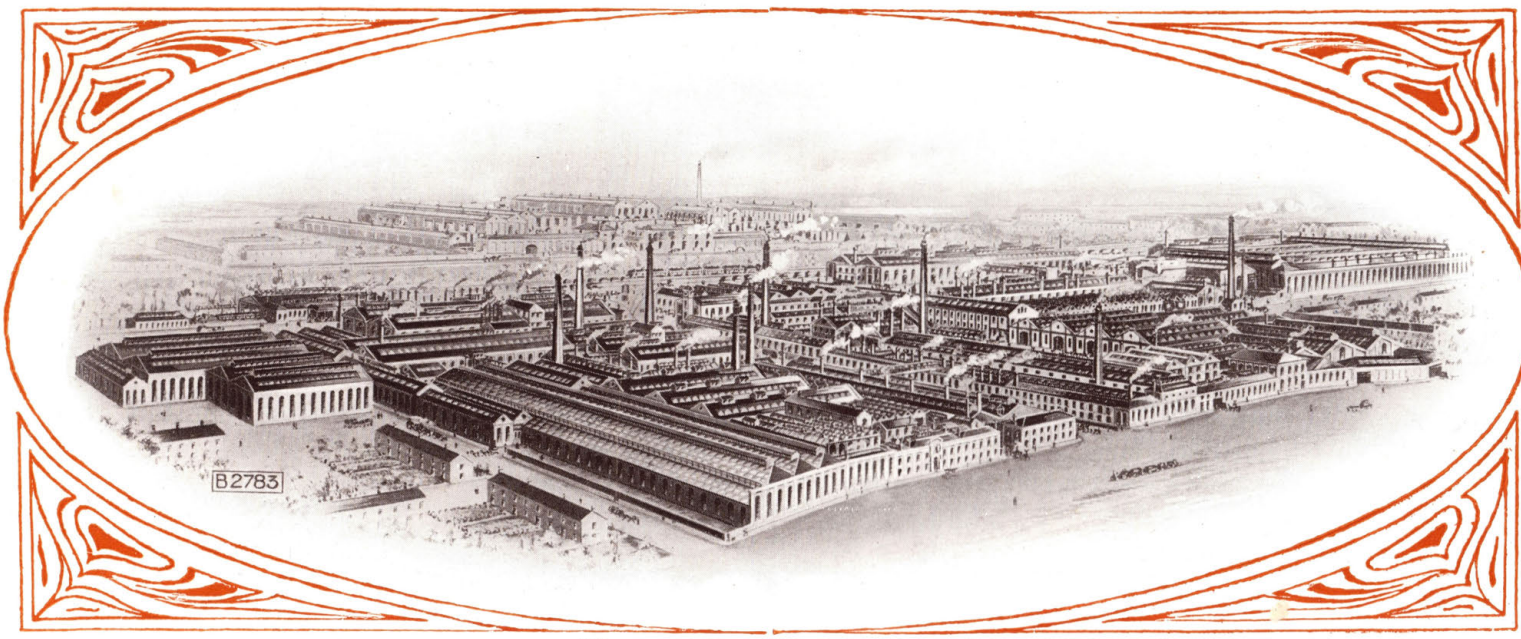

The upper (grouped) view shews our
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The lower view shews our CITY OFFICE: 3 London Wall Buildings, London, E.C.2.

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